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ARGONNE NATIONAL LABORATORY  
9700 South Cass Avenue  
Argonne, Illinois 60439

Comparison of the AMDAHL 470V/6 and the  
IBM 370/195 Using Benchmarks

by

D. R. Snider, J. L. Midlock, A. R. Hinds,  
and D. E. Engert

Applied Mathematics Division

March 1976



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COMPARISON OF THE AMDAHL 470V/6 AND THE  
IBM 370/195 USING BENCHMARKS

by

D. R. Snider, J. L. Midlock, A. R. Hinds,  
and D. E. Engert

ABSTRACT

Six groups of jobs were run on the IBM 370/195 at the Applied Mathematics Division (AMD) of Argonne National Laboratory using the current production versions of OS/MVT 21.7 and ASP 3.1. The same jobs were then run on an AMDAHL 470V/6 at the AMDAHL manufacturing facilities in Sunnyvale, California using the identical operating systems. Performance of the two machines are compared.

Differences in the configurations were minimized. The memory size on each machine was the same, all software which had an impact on run times was the same, and the I/O configurations were as similar as possible. This allowed the comparison to be based on the relative performance of the two CPUs.

As part of the studies preliminary to the acquisition of the IBM 195 in 1972, two of the groups of jobs had been run on a CDC 7600 by CDC personnel in Arden Hills, Minnesota, on an IBM 360/195 by IBM personnel in Poughkeepsie, New York, and on the AMD 360/50/75 production system in June, 1971.

## I. INTRODUCTION

Benchmarks have been widely used in computer acquisition studies. When installed equipment cannot handle projected (or current) workload requirements, the cost/effectiveness of newer and more powerful computers is often evaluated by running selected parts of the workload on demonstration models of the new machines. At Argonne, an ambitious benchmark study was conducted in 1971.<sup>1</sup> The benchmark library from that study consists of two parts:

- a) 28 applications problems representative of, and essential to, the Laboratory's research programs and development projects current in 1971, and
- b) a model jobstream simulating the Central Computing Facility 1971 daytime workload.

AMD is now planning for a computer acquisition. The existing benchmark library was brought up to date, and four new groups of jobs were added to represent the somewhat different workload and research programs current at the Laboratory in 1975. The original jobstream and applications code collections were augmented by a modified model jobstream, a set of current user application codes, a set of small program kernels (drawn mostly from large production codes but including some written specifically for the benchmark), and the Naval Research Laboratory benchmark kernel collection. These six groups were run on the IBM 370/195 at Argonne using the current production versions of OS/360 21.7 and ASP 3.1, and then on a 470V/6 at AMDAHL headquarters (using the same operating systems).

This report describes that experiment in measuring the relative performance of the two CPUs and summarizes the significance of the results obtained. We attempted an objective experiment within the resources available to the project: three man-months were required for planning and execution and many times more could easily have been used.

---

<sup>1</sup>M. K. Butler and Alan Hirsch, Use of the Argonne Benchmark Collection To Measure Computer System Performance, ANL 8127 (September, 1974).

## II. DESIGN OF THE EXPERIMENT

The two major goals of the experiment were:

1. to see if the AMDAHL 470V/6 would run our heavily modified operating systems and jobs with reliability, accuracy, and ease; and
2. to see how fast the 470V/6 is compared to our IBM 370/195.

To accomplish these goals, several procedures were implemented.

First, our production version of OS/360 MVT 21.7 was slightly modified to run on the 470V/6. The Unit Control Blocks (UCBs) in the Input/Output Supervisor (IEAQFXOO) were reassembled to include the devices in the AMDAHL configuration. In addition, the nucleus initialization program (IEAANIPO) was reassembled with modifications supplied by AMDAHL for Recovery Management initialization. AMDAHL modules were copied in for Channel Check Handler, Machine Check Handler, and System Environment Recording; and several modules containing references to the AMDAHL modules were reassembled to point to these modules. It turned out that the changes for Recovery Management were not necessary for the benchmark since we decided to run in "hard stop" to avoid the performance degradation associated with trying to recover from hardware errors.

Second, the ASP initialization deck was modified to match the different hardware configuration on the 470V/6 and a similar stripped-down configuration on our 195. No changes were made to our production version of ASP; it ran on the 470V/6 just as it runs on the 370/195.

Finally, the benchmark library used in 1971 was reactivated and four new parts added to it.

All six parts of the benchmark were run on both machines by the authors. For the two model jobstreams, all of the jobs were read into the ASP queue; then the SLACMON software monitor was started and the jobs were allowed to run. The Argonne SHIFT1 (i.e., the prime shift on weekdays) scheduling parameters were used. These parameters cause four initiators to be started in the top 800K of core memory for EXPRESS class jobs and six initiators to be started in 2200K of core for the bigger jobs. Both machines had four megabytes of memory. The rest of the memory was used for ASP and OS. Only one printer was used for the benchmarks (that was all the 470V/6 had), and only the SYSMSG files were printed. The printer was active while the streams were run. The time to run a stream was defined as the time from when jobs were allowed to start running until the last job completed.

As soon as the last job ended, SLACMON was stopped. When the SYMSMSG files were completed, ASP was terminated to get the CPU time used for the run as measured by SMF. The SLACMON outputs were later compared to check for any significant differences in the utilization of the I/O equipment and for overall CPU utilization of the runs.

The application codes, user codes, and specially tuned code kernels were all run together. The important statistic for each of these jobs was the CPU time required on the different machines. The elapsed time required to run each group of jobs was not measured because the additional comparisons of the I/O speeds of the machines were not considered to be worth the time and effort of running the jobs as separate streams.

#### A. The Model Jobstream

Basically, the Model Jobstream used in this benchmark is identical to that described in Refs. 1 and 2, with the following modifications:

- a) In the original jobstream, several of the jobs were executed several times. Since ASP does not permit concurrent execution of jobs with the same jobname, all jobs in the jobstream were assigned unique jobnames. In the reports, all jobnames were mapped back to their original names.
- b) The AMDAHL hardware configuration did not support 2314 disk drives or 2321 datacells. All jobs requiring these devices were modified to use 3330 disks.
- c) All jobs which depended heavily on operator involvement for mounting tapes were modified to use an online, permanently resident 3330 disk pack. This eliminated the variability inherent in tape mounting.
- d) Several jobs produced more than 50,000 lines of data. Because of our local restriction of a maximum of 50,000 lines of printed data, these jobs had their output directed to tape.
- e) Several of the utility jobs depend upon another job for their successful execution. Where such dependencies exist, the series of jobs was put into an ASP Dependent Job Control (DJC) network to ensure serialized execution.

---

<sup>2</sup>M. K. Butler, Alan R. Hirsch, Sue Katilavas, and M. R. Kraimer, The Argonne Benchmark Problem Collection, Technical Memorandum 213, Argonne National Laboratory (June, 1971).

- f) The CLASS Parameter on the JOB cards was changed to better represent the I/O and/or CPU boundness of the jobs.

The Model Jobstream consists of 60 unique jobs (see Refs. 1 and 2): 37 are typical of the jobs submitted by our users, and 23 are exercises of the commonly used system utility functions. Several of the jobs were run several times, making the total number of jobs in the Model Jobstream run 105.

#### B. Modified Model Jobstream

To place a heavier CPU load on the benchmark machines, the Model Jobstream was augmented by the inclusion of additional CPU bound jobs. These additional jobs were of two types:

- a) selected CPU bound jobs already existing in the Model Jobstream; and
- b) several new jobs (NATRAN, EMATMUL, and DMATMUL described in Appendices C and D).

These jobs contained the same modifications described for the Model Jobstream. The number of jobs in the Modified Model Jobstream totaled 117.

#### C. Applications Problems

One of the groups of jobs used in this benchmark is a subset of the applications problems documented in TM 213. These application problems are, for the most part, written in FORTRAN. The assembly language routines perform well-defined mathematical, character, or bit manipulation, or system-dependent functions. A single PL/1 program is included. Only minimal JCL changes were made to the subset of jobs used in this benchmark. Those jobs from the applications problems which were not included in this benchmark would have required major JCL changes and/or re-programming to be executable; time constraints precluded this.

It was not realized until the data were analyzed at ANL that job SUMX had failed to execute properly because of a lack of scratch space in the LINKEDIT step. This job is included in the report, but it is not counted in the "TOTAL" lines.

For ease in reference and comparison, the jobnames in this subset of applications problems are identical to those described in ANL-8127 and TM-213.

#### D. Current User Production Codes

The original benchmark application code collection, assembled in 1971, was restricted to those applications then implemented on

the IBM 360/75 using models appropriate to the scale of computing power available on that machine. To represent the current Laboratory computing workload more accurately, particularly as it has been influenced by the increase in computing power available on the 370/195, a selection of heavily used, large-scale production codes was added to the benchmark. These codes represent new or extended applications with the 195, and most of them have undergone some tuning to optimize their performance on the current machine.

The user codes selected include representatives from quantum chemistry (BISONINT, OVCBENCH), nuclear reactor design and engineering (DIFIDADJ, DIFIDMOD, DIFIDR), reactor fuel management (BIGREBUS, REBUSTST), and fast reactor transient and accident analysis (FX2DEMO, NATRAN, SASBENCH). The codes are dominated by double precision floating point arithmetic, with NATRAN being the only single precision representative. Most of the codes make use of loop mode and the overlap of floating point arithmetic on the 370/195. All are coded in FORTRAN, compiled on the H compiler at optimization level 2, with the exception of SASBENCH, which is compiled with the G compiler. Further information about the codes can be found in the appendices.

The user codes were executed on the 370/195 using the full production I/O device configuration during normal production time. Since this I/O environment differed substantially from that under which the codes were run on the Amdahl machine, only the CPU times can be usefully compared. Even the CPU times, it should be realized, are subject to some uncertainties owing to the manner in which OS MVT charges CPU time while it is processing interrupts.

#### E. Special Program Kernels

To update the benchmark collection further, a group of program kernels, most of them highly tuned for the 370/195, was extracted from major user production codes or specially written for the benchmark. Use of small kernels rather than entire production codes allowed us to compare performance of code sequences that were easily characterized, whose behavior was well understood on the 195, and which were representative of whole classes of applications programs. Most of the kernels represent time-limiting paths in large codes and thereby reflect the common code tuning efforts which have been undertaken at Argonne.

The kernels selected include tuned paths from the reactor codes SYN3D (DMATMUL, MINVERT) and VIM Monte Carlo Code (MORETEST), the molecular dynamics models of A. Rahman (FSQRT), and the STATOS graphics package (BITSET). As with the user production code collection, the kernels are primarily FORTRAN H (OPT = 2), dominated by double precision floating point arithmetic, although some single precision floating point representatives are included (EMATMUL,

FORTLIBE). Two assembly language kernels are included which perform no floating point arithmetic--a bit manipulation program (BITSET) and a binary table search routine (MORETEST). Most of the kernels take advantage of loop mode on the 370/195, and most achieve significant overlap of floating point addition with floating point multiplication or division.

The jobs DMALMUL/EMATMUL and FORTLIBD/FORTLIBE require special mention. DMATMUL/EMATMUL consist of five separate matrix multiplication algorithms, each invoked for square matrices of ten different dimensions. FORTLIBD/FORTLIBE consist of five separate FORTRAN library routines, each invoked for a set of random arguments. The results section reports total times for these jobs as well as individual times for each matrix multiplication algorithm, each matrix dimension, and each FORTRAN library function.

For the program kernels, only the CPU times are significant, owing to the differing I/O configurations under which they are executed on the 370/195 and AMDAHL 470V/6. The cautions stated for the user production codes are also appropriate here. Further description of these benchmark kernels can be found in Appendix D.

#### F. Naval Research Laboratory Benchmark Kernels

Included in the benchmark were six jobs that were taken from the Naval Research Laboratory benchmark collection. These jobs invoke specially written kernels abstracted from major codes essential to the research programs at NRL, and formed the basis of their recent computer evaluation and acquisition. These kernels were included in the ANL benchmark because of the applicability of their numerical methods to the solution of large classes of scientific problems. The availability of timings for these problems on a variety of machines was considered an additional advantage. Specifically these kernels have been run on the fastest computers now available.

The kernels are compiled under FORTRAN H (OPT = 2) and include a finite fast Fourier transform (NRLICH01), a particle push algorithm (NRLICH02), a Runge-Kutta O.D.E. solver (NRLICH04), a two-dimensional mode coupling problem (NRLICH05), a fluid dynamics algorithm (NRLICH06), and a general matrix and vector arithmetic exerciser (NRLICH07). Except for the last, all the kernels use single precision floating point, with NRLICH07 using single and double precision equally. NRLICH01, NRLICH06, and NRLICH07 take advantage of loop mode, and floating point overlap is probable in most of the examples. NRLICH02, NRLICH04, and NRLICH05 have a high proportion of fixed point addressing and loop management instructions.

For the NRL kernels, only the CPU times can be compared, due to differing I/O device configurations under which they were executed on the 370/195 and AMDAHL 470V/6. Again the cautions stated for the user production codes should be noted. Further description of these benchmark kernels can be found in the Appendix E.

### III. RESULTS

#### A. Jobstream Summary

Tables 1 and 2 summarize the relative performance of the AMDAHL 470V/6 and the IBM 370/195 for the Model and Modified Model Jobstreams. Jobstream elapsed times were measured from the start of the first job to the completion of the last job on MAIN using time-stamped console messages. Total job CPU time and ASP CPU time were obtained from SMF, WAIT time from local accounting modifications, and percent CPU utilization from the SLACMON software monitor.

More detailed results are given in the following sections and in Appendix F.

Table 1

#### Model Jobstream Summary

	<u>AMDAHL 470V/6</u>	<u>IBM 370/195</u>	<u>AMDAHL/IBM</u>
Elapsed time (min:sec)	27:27	30:02	0.914
Total Job CPU time (min:sec)	18:12.07	16:46.22	1.085
Total Job WAIT time (min:sec)	40:50.62	49:03.19	0.833
ASP CPU time (min:sec)	1:41.55	1:55.09	0.882
Total CPU time (min:sec)	20:58	20:22	1.029
CPU utilization	76.36%	67.79%	1.128

Table 2

#### Modified Model Jobstream Summary

	<u>AMDAHL 470V/6</u>	<u>IBM 370/195</u>	<u>AMDAHL/IBM</u>
Elapsed time (min:sec)	45:02	39:44	1.133
Total Job CPU time (min:sec)	39:35.43	33:15.79	1.190
Total Job WAIT time (min:sec)	50:36.86	50:20.54	1.005
ASP CPU time (min:sec)	1:56.05	2:15.58	0.856
Total CPU time (min:sec)	42:21	36:44	1.153
CPU utilization	94.03%	92.47%	1.017

## B. The Model Jobstream

The Model Jobstream consists of 60 unique jobs, some of which were repeated to yield a total of 105 jobs comprising 318 separate job steps. These steps include 52 Assemblies, 17 FORTRAN G compilations, 23 FORTRAN H (OPT=0), compilations, 37 Link Edits, 58 IBM Utility executions, 8 PL/1 compilations, and 123 "GO" steps. This jobstream was assembled in 1971 to represent the daytime workload on the production 360/75; currently, it more closely resembles the 370/195 EXPRESS class workload.

Table 1 shows the stream to be I/O bound on both machines – moreso on the 195. Despite requiring more CPU time than the 195, the 470 completed the jobstream in 9 percent less elapsed time. The lower CPU times for ASP on the 470 suggest that its superior elapsed time is partially attributable to faster provision of system services to the jobstream.

The relative performance of the two machines varies across the jobstream. The ratio of job CPU time used on the 470 to CPU time used on the 195 ranges from .692 to 2.366, with a mean of .963 if each unique job is counted once. Weighting each job by the number of times it occurs in the jobstream shifts the mean to .945 and gives 1.085 for the ratio of total job CPU times. Figures 1 and 2 summarize the relative performance distribution in histogram format.

Table 3 compares the performance of the two machines on different classes of programs, revealing the strengths and weaknesses of each. The AMDAHL 470V/6 excels in executing the language translators and service programs – the compilers, linkage editor, and utilities – as well as the shorter user programs (LOAD&GO). The 370/195 dominates only in the execution of the longer user GO steps, which, however, account for nearly 70% of the stream CPU time. Thus, it appears that the 470 is superior at executing codes dominated by logical, shifting, comparison, and branching instructions while the 195 excels with codes dominated by arithmetic – particularly floating point. This is consistent with the published instruction times for the two machines.<sup>3,4</sup>

---

<sup>3</sup>IBM System/360 and System/370 Model 195 Functional Characteristics, Form GA22-6943, IBM Corporation, New York.

<sup>4</sup>Amdahl 470V/6 Machine Reference, Amdahl Corporation, Sunnyvale, California.

<u>MIDPOINT</u>	<u>COUNT</u>
.70	1   x
.80	17   XXXXXXXXXXXXXXXXXXXX
.90	15   XXXXXXXXXXXXXXXXXXX
1.00	17   XXXXXXXXXXXXXXXXXXXX
1.10	7   XXXXXX
1.20	0
1.30	0
1.40	0
1.50	1   x
1.60	0
1.70	1   x
....	0
2.30	1   x

Total of 60 Unique Jobs

Mean Ratio of Job CPU Times = .963  
 Total Job CPU Time on 470V/6 = 978.02 sec.  
 Total Job CPU Time on 370/195 = 886.23 sec.  
 Ratio of Total Job CPU Times = 1.104

Figure 1. Distribution of CPU Time Ratios for Model Jobstream -  
 Each Unique Job Counted Only Once.

<u>MIDPOINT</u>	<u>COUNT</u>
.70	1  x
.80	29  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.90	32  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.00	31  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.10	9  XXXXXXX
1.20	0
1.30	0
1.40	0
1.50	1  x
1.60	0
1.70	1  x
....	0
2.30	1  x

Total of 105 Jobs

Mean Ratio of Job CPU Times = .945  
 Total Job CPU Time on 470V/6 = 1092.07 sec.  
 Total Job CPU Time on 370/195 = 1006.22 sec.  
 Ratio of Total job CPU Times = 1.085

Figure 2. Distribution of CPU Time Ratios for Model Jobstream - All Jobs in Jobstream Included.

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 MODEL JOBSTREAM

19

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES WEIGHTED BY THE NUMBER OF TIMES EACH STEP WAS RUN

STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ASM	52	0.26	5.21	52	0.29	6.52	0.900	0.800
EDT	37	0.30	10.33	37	0.36	9.11	0.840	1.134
FTG	17	1.51	2.02	17	1.95	2.33	0.773	0.868
FTH	23	4.20	13.91	23	5.02	10.24	0.836	1.359
GO	89	8.39	3.80	89	6.71	6.91	1.251	0.549
IEBUTIL	33	0.21	9.34	33	0.22	11.03	0.966	0.847
IEHUTIL	25	0.22	9.06	25	0.23	6.50	0.960	1.395
LOAD&GO	34	4.94	14.44	34	5.77	22.54	0.857	0.641
PL1	8	2.20	9.88	8	2.85	10.49	0.773	0.942

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBs	CPU	WAIT	JOBs	CPU	WAIT	CPU	WAIT
ASM	5	0.47	8.15	5	0.52	12.48	0.896	0.730
EDT	21	0.31	9.90	21	0.36	9.01	0.863	1.199
FTG	10	2.20	2.19	10	2.85	2.64	0.770	0.916
FTH	23	4.20	13.91	23	5.02	10.24	0.840	1.417
GO	21	12.36	4.76	21	9.46	9.23	1.387	1.357
IEBUTIL	16	0.23	11.48	16	0.24	11.82	0.949	1.205
IEHUTIL	9	0.26	11.28	9	0.27	8.20	0.944	1.441
LOAD&GO	14	5.86	16.82	14	6.86	26.60	0.910	1.046
PL1	3	4.04	13.73	3	5.35	16.74	0.791	1.026

Table 3. Summary of Results for Model Jobstream - Performance Ratios by Program Type.

### C. The Modified Model Jobstream

The Modified Model Jobstream consists of the Model Jobstream augmented by additional CPU bound jobs to more closely represent the current daytime computing workload of the production 370/195. A total of 117 jobs, of which 64 are unique, contribute 362 job steps to this stream.

Table 2 shows the modified stream to be CPU bound on both machines, with CPU utilizations exceeding 90 percent. The extra CPU load has extended the 470 stream time nearly twice as much as the 195 stream time, overwhelming the small advantage the 470 had on the Model Jobstream.

The ratio of job CPU time used on the 470 to CPU time used on the 195 ranges from .692 to 2.673 with a mean of 1.007 if each job is counted once. Weighting each job by the number of times it occurs in the jobstream shifts the mean to 1.004 and gives 1.190 for the ratio of the total job CPU times. Figures 3 and 4 present the relative performance distributions in histogram format.

Table 4 updates the comparisons in Table 3 for the inclusion of the additional CPU bound jobs.

<u>MIDPOINT</u>	<u>COUNT</u>
.70	2   XX
.80	17   XXXXXXXXXXXXXXXXXXXX
.90	15   XXXXXXXXXXXXXXXXXX
1.00	17   XXXXXXXXXXXXXXXXXX
1.10	8   XXXXXXXXX
1.20	0
1.30	0
1.40	0
1.50	1   X
1.60	1   X
1.70	1   X
1.80	0
1.90	0
2.00	0
2.10	0
2.20	0
2.30	1   X
2.40	0
2.50	0
2.60	1   X

Total of 64 Unique Jobs

Mean Ratio of Job CPU Times = 1.007  
 Total Job CPU Time on 470V/6 = 1638.80  
 Total Job CPU Time on 370/195 = 1385.00  
 Ratio of Total Job CPU Times = 1.183

Figure 3. Distribution of CPU Time Ratios for Modified Model Jobstream  
 Each Unique Job Counted Only Once.

<u>MIDPOINT</u>	<u>COUNT</u>
.70	2   XX
.80	29   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.90	32   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.00	35   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
1.10	10   XXXXXXXXXX
1.20	0
1.30	0
1.40	0
1.50	1   X
1.60	1   X
1.70	5   XXXXX
1.80	0
1.90	0
2.00	0
2.10	0
2.20	0
2.30	1   X
2.40	0
2.50	0
2.60	1   X

Total of 117 Jobs

Mean Ratio of Job CPU Times = 1.004  
 Total Job CPU Time on 470V/6 = 2375.43  
 Total Job CPU Time on 370/195 = 1995.79  
 Ratio of Total Job CPU Times = 1.190

Figure 4. Distribution of CPU Time Ratios for Modified Model Jobstream - All Jobs in Jobstream Included.

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES WEIGHTED BY THE NUMBER OF TIMES EACH STEP WAS RUN

STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ASM	52	0.27	4.15	52	0.29	4.74	0.920	0.875
EDT	45	0.30	9.40	45	0.37	8.91	0.808	1.055
FTG	17	1.49	1.92	17	1.90	1.81	0.782	1.057
FTH	35	3.85	12.01	35	4.61	9.41	0.834	1.277
GO	109	12.21	5.77	109	9.43	6.35	1.295	0.908
IEBUTIL	33	0.22	8.75	33	0.22	11.05	0.978	0.792
IEHUTIL	25	0.22	8.89	25	0.23	6.14	0.939	1.448
LOAD&GO	38	21.76	19.54	38	18.59	19.21	1.170	1.017
PL1	8	2.22	7.85	8	2.85	9.05	0.777	0.867

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOBs	CPU	WAIT	JOBs	CPU	WAIT	CPU	WAIT
ASM	5	0.47	7.53	5	0.52	8.51	0.909	0.876
EDT	21	0.30	9.49	21	0.37	8.77	0.836	1.110
FTG	10	2.16	1.82	10	2.76	1.74	0.779	1.173
FTH	27	3.89	11.23	27	4.67	8.81	0.839	1.392
GO	21	12.18	9.01	21	9.09	10.11	1.422	1.066
IEBUTIL	16	0.25	9.39	16	0.26	11.88	0.982	1.217
IEHUTIL	9	0.26	10.76	9	0.27	7.72	0.928	1.447
LOAD&GO	18	41.11	20.42	18	33.67	20.10	1.046	0.889
PL1	3	4.08	9.70	3	5.32	12.82	0.789	0.879

Table 4. Summary of Results for Modified Model Jobstream - Performance Ratios by Program Type.

#### D. Applications Problems

Tables 5 and 6 summarize the performance of the Applications Problems collection on the benchmark machines. Note particularly the differences in relative performance of the single and double precision problems. Average GØ step execution times are recorded, with each job counting once in the tabulated totals and means regardless of how often it was included in the problem collection.

Complete results for the Applications Problems are in Appendix F.

#### E. Current User Production Codes and Special Kernels

Table 7 summarizes the performance of the User Code and Special Kernel GØ steps on the benchmark machines. Average execution times are recorded, with each job contributing once to the tabulated totals and means. Complete results are in Appendix F.

#### F. Naval Research Laboratory Benchmark Kernels

Table 8 summarizes the performance of the N.R.L. Benchmark Kernel GØ steps on the benchmark machines. Complete results are in Appendix F.

#### G. Summary of Performance Ratios

Table 9 summarizes the CPU performance of the benchmark machines for the major categories of work comprising this study. Data for ASP, the language translators and service programs were obtained by combining the Model and Modified Model Jobstream results with the exception of FORTRAN H OPT=2 data that was obtained from the Applications Problems, Special Kernel, and N.R.L. Benchmark Kernel collections. The tabulated mean cpu time ratios were obtained by averaging the job performance ratios in each grouping, counting each unique job once regardless of how often it was included in the benchmark.

**ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS**

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = LOAD&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751	
DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820	
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634	
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742	
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926	
HEPCVT	1	61.64	10.64	1	74.68	12.21	0.825	0.871	
KTTLFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925	
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721	
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583	
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820	
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137	
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160	
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611	
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819	
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451	
TOTAL	15	2143.60	181.75	15	1808.36	238.16	1.185	0.763	
MEAN	15	142.91	12.12	15	120.56	15.88	1.312	0.998	
*****									
STEP = EDT&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
SUMX	1	0.44	4.39*	1	72.57	31.80			
TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126	
*****									

Table 5. Summary of Results for Applications Problems.

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
DOUBLE PRECISION APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = LOAD&GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751	
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634	
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742	
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721	
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583	
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820	
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137	
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819	
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451	
*****									
TOTAL	9	1358.35	38.15	9	930.17	57.23	1.460	0.667	
MEAN	9	150.93	4.24	9	103.35	6.36	1.583	1.184	
*****									

SINGLE PRECISION APPLICATIONS PROBLEMS

STEP = EDT&GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
*****								
LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126
*****								
TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126
*****								

AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

STEP = LOAD&GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
*****								
DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926
KTTLFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611
*****								
TOTAL	5	723.61	132.96	5	803.51	168.72	0.901	0.788
MEAN	5	144.72	26.59	5	160.70	33.74	0.923	0.688
*****								

Table 6. Summary of Results for Applications Problems - Single Precision and Double Precision Floating Point.

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
USER JOBS AND TUNED KERNELS

27

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM							
STEP = LOADGO															
<hr/>															
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
DMATMUL	1	242.83	1.43	1	87.96	1.47		2.761	0.973						
EMATMUL	1	139.24	1.46	1	88.47	1.43		1.574	1.021						
FORTLIBD	1	116.57	2.58	1	78.05	3.75		1.494	0.688						
FORTLIBE	1	71.51	2.66	1	82.75	6.65		0.864	0.400						
FSQRT	1	296.61	1.35	1	82.66	2.08		3.588	0.649						
MINVERT	1	80.63	1.38	1	69.82	1.32		1.155	1.045						
NATRAN	1	88.98	2.11	1	79.69	4.42		1.117	0.477						
TOTAL	7	1036.37	12.97	7	569.40	21.12		1.820	0.614						
MEAN	7	148.05	1.85	7	81.34	3.02		1.793	0.751						
<hr/>															
STEP = GO															
<hr/>															
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
BIGREBUS	1	506.52	382.78	1	279.36	335.52		1.813	1.141						
BISONINT	1	649.65	593.18	1	379.54	329.20		1.712	1.802						
BITSET	1	28.63	0.15	1	39.27	0.18		0.729	0.833						
DIF1DADJ	1	130.59	17.03	1	73.94	16.96		1.766	1.004						
DIF1DMOD	1	512.97	36.72	1	292.34	54.68		1.755	0.672						
DIF1DRL	1	35.51	17.51	1	21.70	16.37		1.636	1.070						
FX2DEMO	1	453.98	281.06	1	321.12	290.55		1.414	0.967						
MORETEST	2	33.39	0.25	2	40.56	0.44		0.823	0.562						
OVCBENCH	1	621.05	133.81	1	278.66	104.60		2.229	1.279						
REBUSTST	1	113.64	151.79	1	77.86	159.68		1.460	0.951						
SASBENCH	1	193.59	4.33	1	171.03	7.05		1.132	0.614						
TOTAL	11	3279.52	1618.61	11	1975.38	1315.23		1.660	1.231						
MEAN	11	298.14	147.15	11	179.58	119.57		1.497	0.990						
<hr/>															

Table 7. Summary of Results for User Jobs and Tuned Kernels.

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
NRL BENCHMARK KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT		CPU	WAIT
<hr/>									
NRLICH01	1	163.54	21.77	1	157.47	6.98		1.039	3.119
NRLICH02	1	129.98	15.13	1	111.97	4.49		1.161	3.370
NRLICH04	1	127.92	20.89	1	110.59	8.69		1.157	2.404
NRLICH05	1	150.43	7.07	1	136.43	7.82		1.103	0.904
NRLICH06	1	154.67	5.94	1	124.94	5.25		1.238	1.131
NRLICH07	1	221.75	4.14	1	94.29	3.66		2.352	1.131
<hr/>									
TOTAL	6	948.29	74.94	6	735.69	36.89		1.289	2.031
MEAN	6	158.05	12.49	6	122.61	6.15		1.341	2.010

STEP = GO

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT
<hr/>									
NRLICH01	1	162.38	0.26	1	156.05	0.58		1.041	0.448
NRLICH02	1	129.18	0.41	1	110.98	0.18		1.164	2.278
NRLICH04	1	127.10	0.28	1	109.61	0.30		1.160	0.933
NRLICH05	1	149.26	0.23	1	134.94	0.20		1.106	1.150
NRLICH06	1	153.58	0.21	1	123.62	0.22		1.242	0.955
NRLICH07	1	220.45	0.27	1	92.70	0.21		2.378	1.286
<hr/>									
TOTAL	6	941.95	1.66	6	727.90	1.69		1.294	0.982
MEAN	6	156.99	0.28	6	121.32	0.28		1.348	1.175

Table 8. Summary of Results for Naval Research Laboratory Benchmark Kernels.

	<u>Total Steps</u>	<u>Total Jobs</u>	<u>Unique Jobs</u>	<u>Mean CPU Ratio AMDAHL/IBM</u>
ASP	2	2	2	.869
ASSEMBLER F	104	52	5	.915
FORTRAN G	34	34	10	.776
FORTRAN H	91	91	56	.814
OPT=0	58	58	27	.840
OPT=2	33	33	29	.791
LINK EDIT	82	68	21	.850
PL/I F	16	6	3	.790
OS UTILITIES	116	106	23	.958
'IEB' UTILITIES	66	66	16	.966
'IEH' UTILITIES	50	42	9	.936
GO & LOAD&GO STEPS	313	185	113	1.291
MODEL JOBSTREAM	123	65	35	1.196
MODIFIED JOBSTREAM	147	77	39	1.248
APPLICATIONS PROBLEMS	20	20	16	1.281
LARGE USER CODES	9	9	9	1.534
SPECIAL JOB KERNELS	8	8	8	1.617
NRL KERNELS	6	6	6	1.348
SINGLE PRECISION GO STEPS	17	17	15	1.044
APPLICATIONS PROBLEMS	8	8	6	.901
LARGE USER CODES	1	1	1	1.117
SPECIAL JOB KERNELS	2	2	2	1.219
NRL KERNELS	5	5	5	1.142
FORTRAN LIBRARY	1	1	1	.996
DOUBLE PRECISION GO STEPS	24	24	22	1.711
APPLICATIONS PROBLEMS	11	11	9	1.583
LARGE USER CODES	8	8	8	1.586
SPECIAL JOB KERNELS	4	4	4	2.250
FORTRAN LIBRARY	1	1	1	1.706

Table 9. Benchmark Summary Data -  
Mean CPU Time Performance Ratios.

#### IV. EVALUATION OF EXPERIMENT

Figures 5 and 6 show the hardware configurations used in the experiment. In each configuration the 2305 was used for SYS1.SYSJOBQE, the frequently used members of SYS1.LINKLIB, SYS1.FORTLIB, and SYS1.AMDLIB (a library of popular local mathematical subroutines). A single systems resident disk contained the remainder of O.S. Two disks were used as STORAGE/PERMANENTLY RESIDENT for the allocation of temporary and non-temporary datasets. One disk was used as PRIVATE/PERMANENTLY RESIDENT for the input datasets required by some of the jobs. Two disks were used as ASP queue packs.

The I/O device configurations were quite limited for such powerful CPUs. The limitation was imposed by the amount of hardware available on the AMDAHL benchmark machine. The only real bottleneck, however, was caused by the operating system's tendency to allocate most of the temporary datasets on the same disk. The STORAGE disk with the lowest address was much too busy on both the configurations. As a result, the CPU utilization was low for the two jobstreams, and the elapsed times for the streams were longer than they should have been. Since this problem is also present on our production system, the benchmark is believed valid despite the bottleneck.

A log was kept of the activities and problems during the running of the benchmark at AMDAHL and is included in Appendix B. The problems were minor, and to be expected since the AMDAHL hardware engineers had to reconfigure the test machine for the experiment. We were pleased that the benchmark runs were accomplished in only two days.

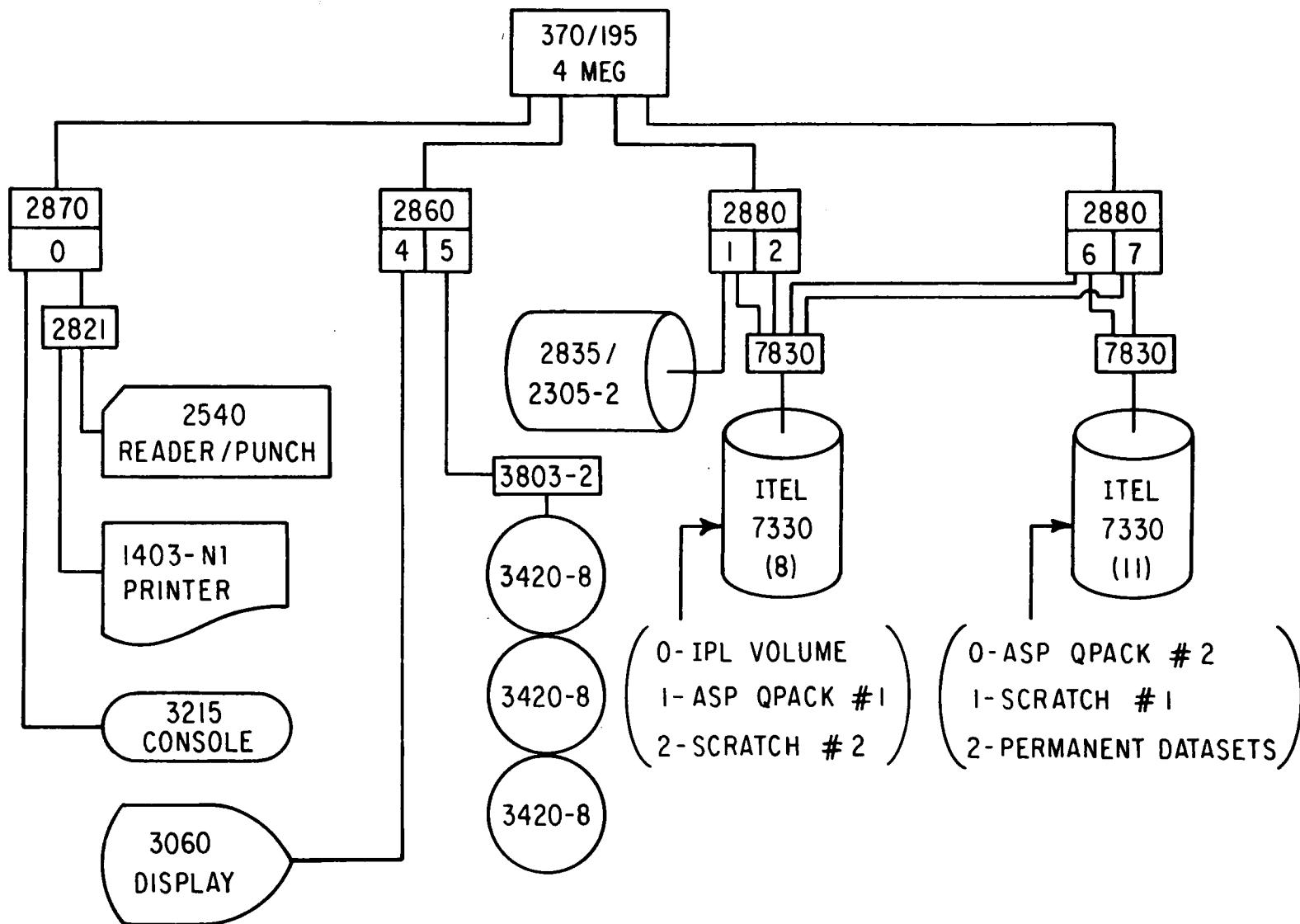


Figure 5. IBM 370/195 Benchmark Hardware Configuration.

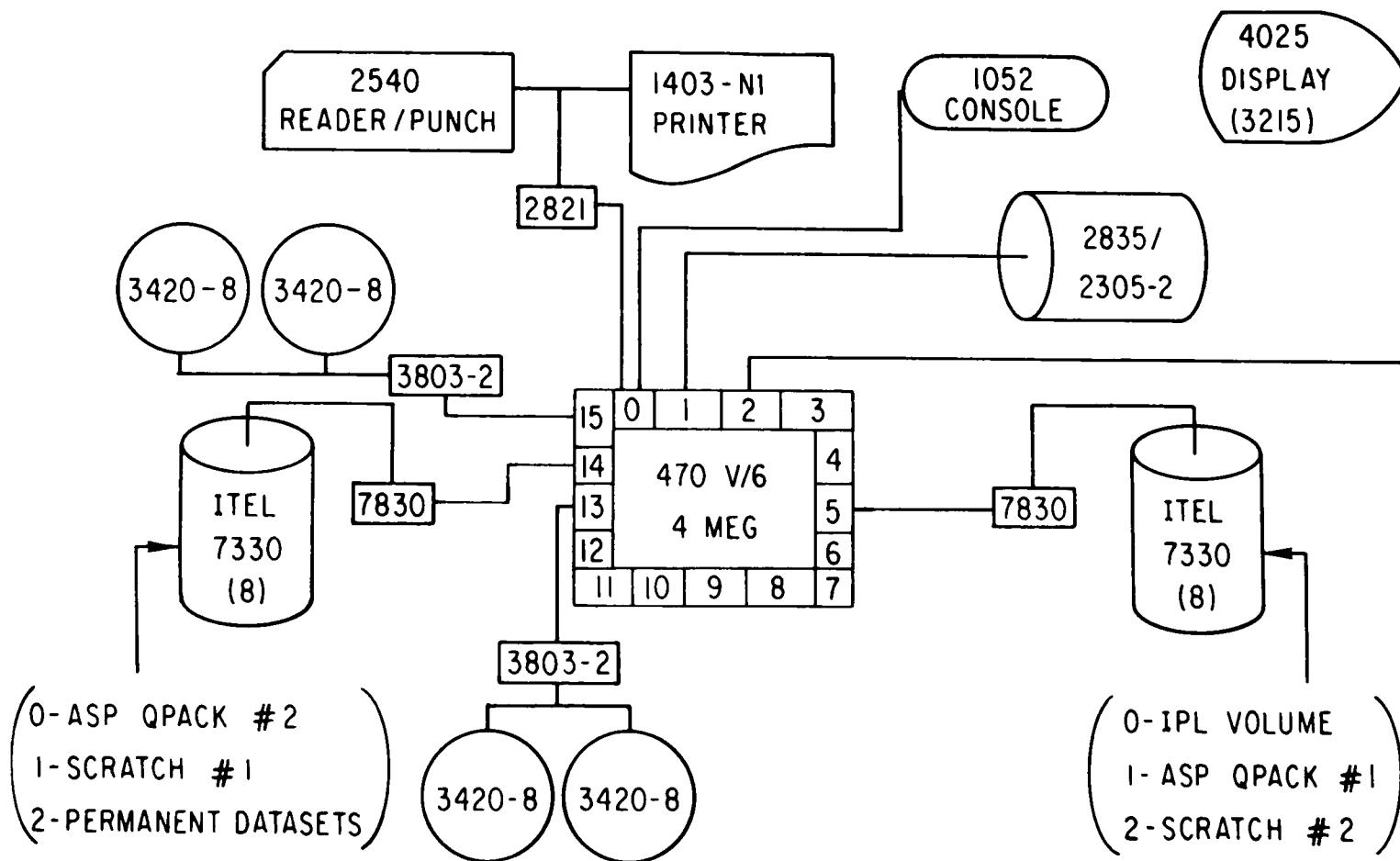


Figure 6. AMDAHL 470V/6 Benchmark Hardware Configuration.

## V. SUMMARY

The AMDAHL 470V/6 compares favorably with the IBM 370/195 for certain classes of work. It was 10-20 percent faster at running ASP, compilers, and the Linkage Editor. The higher CPU utilization and shorter run time for the Model Jobstream on the AMDAHL machine are partially attributed to its ability to run the operating system faster than the 195. The 195 was faster, on average, at running GØ steps, which appears to be due almost entirely to the 195's high performance double precision floating point. Programs using little or no floating point or only single precision ran faster, or only marginally slower, on AMDAHL. For double precision, however, applications codes ran typically 20-80 percent faster and tuned kernels up to 400 percent faster on the 195. The absence of a "loop mode" on AMDAHL seemed adequately compensated for by its faster cache memory access time.

ACKNOWLEDGMENTS

The cooperation and assistance of Bob Phillips and his co-workers at AMDAHL are gratefully acknowledged. From AMD, Dave Jacobsohn made the initial contacts and helped get the trip set up; and Louis Just kept the benchmark log and acted as our troop leader.

## APPENDIX A

### Benchmark ASP Initialization Deck

```

//BENCHASP JOB (W17783.50..1439).CLASS=A.REGION=736K.MSGLEVEL=1
//GOASP PROC RV=RES195.RU=3330.AV=PACK14.AU=3330.
//          QU=3330.Q1=PACK63.Q2=PACK60
// EXEC PGM=ASPNUC.DPRTY=13
//STEPLIB DD DSN=ASP.V3M10.CR3.DISP=SHR.
//          UNIT=&RU.VOL=SER=&RV
//          DD DSN=SYSA.LINKLIB.DISP=SHR
//ASPQ1   DD DSN=ASP.BENCH.Q1.DISP=OLD.
//          UNIT=&QU.VOL=SER=&Q1
//ASPQ2   DD DSN=ASP.BENCH.Q2.DISP=OLD.
//          UNIT=&QU.VOL=SER=&Q2
//CHKPNT  DD DSN=ASP.BENCH.CHPNT.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//ASPDRLDS DD DSN=B14591.AMDAHL.BENCH.DISP=SHR.UNIT=3330.VOL=SER=PACK1+
//CONTROL  DD DSN=ASP.BENCH.CONTROL.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//MAIN     DD DSN=ASP.BENCH.MAIN.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//BACKUP   DD DSN=ASP.BENCH.BACKUP.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//NACCOUNT  DD DSN=ASP.BENCH.NACCOUNT.DISP=MOD.
//          VOL=SER=&AV.UNIT=&AU
//SUPERCTL DD DSN=ASP.BENCH.SUPER.CONTROL.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//ACCTFILE DD DSN=ASP.BENCH.AUTHFILE.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//LWVAFILE DD DSN=ASP.BENCH.VALDFILE.DISP=SHR.
//          VOL=SER=&AV.UNIT=&AU
//STATFILE DD DSN=ASP.BENCH.STATFILE.DISP=MOD.
//          VOL=SER=&AV.UNIT=&AU
//ASPOUT   DD SYSOUT=A
//ASPABEND DD SYSOUT=A.DCB=BLKSIZE=582
//ASPSNAP  DD SYSOUT=A.DCB=BLKSIZE=582
//SYSABEND DD SYSOUT=A
//IEFRDR   DD DUMMY
//IEFDATA   DD DUMMY
//IEFPDSI  DD DSN=SYSA.PROCLIB.DISP=SHR
//          DD DSN=SYSA.AMDPROC.DISP=SHR
//          PEND
//          EXEC GOASP
//ASPIN    DD *
***** BEGIN OF ASP INITIALIZATION DECK *****
***** RESIDENT MODULES *****
RESIDENT MODULE=(IEFVHCB,IEFVFH,IEFVHREP,IEFVHA)             00131000
RESIDENT MODULE=(IEFMVTJA,IEFVJA,IEFVINA)                   00133000
RESIDENT MODULE=(IEFVMT,IR,IEFHRFK2,IEZDCODE)              00139000
RESIDENT MODULE=(IEFVGM1,IEFVGM2,IEFVGM3,IEFVGM4,IEFVGM5,IEFVGM6) 00140000
RESIDENT MODULE=(IEFVGM7,IEFVGM8,IEFVGM9,IEFVGM10,IEFVGM11,IEFVGM12) 00141000
RESIDENT MODULE=(IEFVGM13,IEFVGM14,IEFVGM15,IEFVGM16,IEFVGM17,IEFVGM18) 00142000
RESIDENT MODULE=(IEFVGM19,IEFVGM70,IEFVGM71,IEFVGM78)        00143000
RESIDENT MODULE=(PRTSETUP,JSS,MSVMVT,PRTTERM)               00144000
RESIDENT MODULE=(PRTOUT,MAIN,MAINIO,RDLOGIC,ISENDTSK)        00145000
RESIDENT MODULE=(ISLOGIC,ISJOBCRD,PURGE,PRTINISH)           00147000
RESIDENT MODULE=(MSVLOCAL,MSDSDRIVR,MSVINIT,MSVTERM)         00148000
RESIDENT MODULE=(MPDATA,MPDATA)                                00149000
RESIDENT MODULE=(PRTDATA)                                     0014A000

```

RESIDENT. MODULE=(RCHDATA, CR, RIDATA, RIDATA, RIDATA) 00152000  
 RESIDENT. MODULE=(RDDATA, PURDATA, MDSDATA, CONTRAP, PN, PRINT) 00156000  
 RESIDENT. MODULE=(MSVDATA, MSVDATA, MSVDATA, MSVDATA, MSVDATA) 00157000  
 RESIDENT. MODULE=(MSVDATA, MSVDATA, MSVDATA, MSVDATA, MSVDATA) 00157000  
 RESIDENT. MODULE=(CONS1052, CONSANAL, RICBAM, RIEXITS, DJCUPDAT)  
 COLDSTART. JOBNO=(1.9999) 00174000  
 \* 00174000  
 \*\*\*\*\* TRACK CARDS & BUFFER CARDS FOR SYSTEM TESTING (2314) 00175000  
 \* 00176000  
 BUFFER. AMOUNT=115. BUFSIZE=1688. RECORDS=7. IOBS=12. TAT=HALF  
 TRACK. DDNAME=ASPO1  
 TRACK. DDNAME=ASPO2 00182000  
 \* 00182000  
 \*\*\*\*\* REQUIRED STORAGE NEEDS 00183000  
 \* 00183000  
 OPTIONS. ADDSAVE=40. DUMP=OS 00184000  
 ASPCORE. MINCORE=14K. MARGCORE=24K 00185000  
 ENDASPIO 00186000  
 \* 00187000  
 \* 00188000  
 \*\*\*\*\* RESIDENCY OPTIONS 00189000  
 \* 00189000  
 RESCLBK. ASG=20. FCT=30. RQ=400. VUT=30 00190000  
 \* 00190000  
 \*\*\*\*\* READER/INTERPRETER 00191000  
 \* 00191000  
 \* 00192000  
 \* 00193000  
 \* 00194000  
 RIDATSTN. SYS1. AMDLIB. SYS1. SORTLIB. SYS1. PL1LIB. SYS1. FORTLIB 00195000  
 RIDATSTN. SYS1. PROCLIB. SYS1. LINKLIB. SYS1. LNLKLIB. SYS1. AMDPROC 00196000  
 RIDATSTN. SYS1. MACLIB. SYS1. SVCLIB. SYS1. AMDMAC. SYS1. AMDLIB2 00197000  
 RIDATSTN. SYS1. PLICLNK. SYS1. PLICMIX. SYS1. PLIBASE. SYS1. PLITASK 00198000  
 RIDATSTN. SYS1. FORTHX. SYS1. FORTLIB2. SYS1. FORTG1. PLI. CHECK. LINKLIB 00199000  
 RIDATSTN. PLI. TRANSLIB. SYS1. DUMMYLIB. SYS2. IMSLIB. PLI. OPT. LINKLIB 00200000  
 RI. BLDL=(FTGCLG. FTGCEG. FTGCEP. FTHCLG. FTHCEG. FTHCEP) 00201000  
 RIPARM. PARM=(00099905001024906431SYSDA E00011A) 00202000  
 DEVICE. STYPE=OSRDR. SUPPORT=(NONE. OSRI1). GTYPE=ARI 00203000  
 DEVICE. STYPE=OSRDR. SUPPORT=(NONE. OSRI2. LOG.OFF). GTYPE=ARI 00204000  
 DEVICE. STYPE=OSRDR. SUPPORT=(NONE. OSRI3. LOG.OFF). GTYPE=ARI 00205000  
 \* 00206000  
 \*\*\*\*\* MAIN SERVICE 00207000  
 \* 00207000  
 \* 00208000  
 \* 00209000  
 \* 00210000  
 \* 00211000  
 \* 00212000  
 X  
 SY1  
 MAINPROC. NAME=SY1. MAINCTC=810. ADAPTER=810. CTCCUA=(1.2.3.4). MDEST=M1. \*00211000  
 SELECT=SHIFT1. \*00212000  
 SYSTEM=LOCAL.  
 RID=R1#. SID=S1#. MSGCLASS=C. JOBCCLASS=(D.E.F.G)  
 DEVICE. STYPE=MAIN. SUPPORT=(810. SY1.. OFF). GTYPE=SYS 00214000  
 \* 00215000  
 SHIFT1  
 SELECT. NAME=SHIFT1. MINIT=11. MBAR=14. SBAR=13. SJSPAN=255. MJSPAN=60. X00216000  
 REGROUP=(E. EXPRESS. EXP. EXPRESS). X00216100  
 DISPLAY=NONE. SDEPTH=40. INCR=3. GROUP=(EXPRESS. 4. G2250. 1. ASPBATCH. 6). X00217000  
 DPRTY=0. INCL=12. MPSPAN=5. SPSPAN=3. CHOICE=(BJOB. FMIX. FFIT). CLASS=/N 00218000  
 \* 00219000  
 SHIFT2  
 SELECT. NAME=SHIFT2. MINIT=12. MBAR=14. SBAR=13. MJSPAN=255. SJSPAN=255. X00220000  
 REGROUP=(E. NEXPRESS. EXP. NEXPRESS). X00220100  
 DISPLAY=NONE. SDEPTH=40. INCR=3. DPRTY=0. X00221000  
 GROUP=(ASPBATCH. 10. G64K. 1. NEXPRESS. 1). X00222000  
 MPSPAN=5. SPSPAN=5. CHOICE=(BJOB. FMIX. FFIT). CLASS=/N. INCL=12 00223000  
 \* 00224000  
 SHIFT3  
 SELECT. NAME=SHIFT3. MINIT=11. MBAR=14. SBAR=13. MJSPAN=255. SJSPAN=255. X00225000  
 REGROUP=(E. NEXPRESS. EXP. NEXPRESS). X00225100  
 DISPLAY=NONE. SDEPTH=40. INCR=3. DPRTY=0. X00226000

```

GROUP=(ASPBATCH,8.664K,1.NEXPRESS,1).          X00227000
MPSPAN=5. SPSpan=5. INCL=12. CHOICE=(BFIT)      00222000
*           SYSPROGM                         00229000
SELECT. NAME=SYSPROGM. GROUP=(SYSPROGM,1). DPRTY=2 00230000
*           GROUPS AND CLASSES                  00231000
CLASS. NAME=A. IORATE=HIGH. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=B. IORATE=MED. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=C. IORATE=LOW. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=J. IORATE=HIGH. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=K. IORATE=MED. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=L. IORATE=LOW. JPRTY=ASP. NCLASS=EXP
CLASS. NAME=N. JPRTY=ASP                         00241000
GROUP. NAME=EXPRESS. EXRESC=(SY1.4.800K. IPL.MANUAL). PRTY=0 00242000
GROUP. NAME=NEXPRESS. EXRESC=(SY1.1.. IPL.MANUAL). PRTY=0      X
CLASS. NAME=E. IORATE=HIGH. JPRTY=ASP. ANLPRTY=(13.N.11).      00244000
LIMITS=(2..2.250.1.1). GROUP=EXPRESS            X
CLASS. NAME=EXP. IORATE=HIGH. JPRTY=ASP. ANLPRTY=(13.N.11).      00246000
LIMITS=(2..2.250.1.1). GROUP=EXPRESS            X
GROUP. NAME=G2250. EXRESC=(SY1.1.500K. DYNAMIC.DYNAMIC). PRTY=1 00247000
CLASS. NAME=G. IORATE=HIGH. JPRTY=ASP. GROUP=G2250
GROUP. NAME=G64K. EXRESC=(SY1.1.64K. DYNAMIC.DYNAMIC). PRTY=1 00249000
CLASS. NAME=TPT. IORATE=HIGH. JPRTY=ASP. GROUP=G64K
GROUP. NAME=SYSPROGM. EXRESC=(SY1.1)               00252000
CLASS. NAME=S. IORATE=HIGH. JPRTY=ASP. SYSTEM=ANY. GROUP=SYSPROGM
*
***** CONSOLES
*
CONSOLE. DDNAME=CN1. TYPE=3215. UNIT=009. MAIN=SY1. ALTCOM=CN2.      X
DEST=OUTPUT
CONSOLE. DDNAME=CN2. TYPE=3060. UNIT=4F0. ALTCOM=CN1.      X
DEST=NONE
*
***** MDS
*
SETPARAM. DEPTH=50. MDSLOG=S32. REMOUNT=5             00271000
***** TAPES
SETNAME. MTYPE=34206.                                X00272000
NAMES=(3420-6.TAPE6250.3420-8.DUALDENS.3400-6.3400-5) 00273000
*
***** SY1 DEVICES - TAPES
*
DEVICE. STYPE=34206. SUPPORT=(5A5.T30.S1). MTYPE=34206. MAIN=(5A5.SY1.S1). X
GTYPE=TA9
DEVICE. STYPE=34206. SUPPORT=(5A6.T31.S1). MTYPE=34206. MAIN=(5A6.SY1.S1). X
GTYPE=TA9
DEVICE. STYPE=34206. SUPPORT=(5A7.TF0.S1). MTYPE=34206. MAIN=(5A7.SY1.S1). X
GTYPE=TA9
*
***** SUPPORT UNIT RECORD DEVICES
*
DEVICE. STYPE=2540. SUPPORT=(000.RD1). GTYPE=RDR. CHRGE=YES 00426000
DEVICE. STYPE=2540. SUPPORT=(000.PU1.D2). GTYPE=PUN        00427000
DEVICE. STYPE=1403. SUPPORT=(00E.PR1.D2). GTYPE=PRT. CHRGE=YES 00428000
PRINTER. NAME=PR1. FORMS=NO. TRAIN=NO. BUFDED=YES       00429000
*
***** ANL ACCOUNTING CONTROL CARDS (PRECEDE STANDARD CARDS)
*
PRIORITY. T=(13.3.00). H=(11.1.50). N=(09.1.00). L=(6.0.80). S=(0.0.60) 00504000
ACCNT1. CPUCHRG=00.03194. PRINT=00.0001. PUNCH=00.001. DISKSETP=01.00 00505000
ACCNT2. TAPESETP=00.25. PREEL=00.50. FILM=02.00. SPECPR=05.00 00506000

```

ACCTN3. SPEC CPU=02.00.2250=20.00.OTCCARDS=00.001.	X00507000
STANDBY=15.00.CPUREGN=00.00361.WAITREGN=00.00361.WAITCHRG=00.03194	00508000
*	00509000
***** STANDARDS	00510000
*	00511000
STANDARDS.FORMS=STANDARD.CARRIAGE=STANDARD.TRAIN=PN.LINES=(1.DUMP).	#00512000
HBAR=ON.TBAR=61.RBAR=2050.RTBAR=220000.	#00513000
CARDS=(2.DUMP).PRTY=09.FLOCATE=NO.DLOCATE=YES.CONSBUF=20.SQS=6K.	#00514000
FAILURE=CANCEL.NOPU=A.CLASS=J.FETCH=ALL.MLOG=NO	
SYSOUT.	X
COPIES=0.	X
CLASS=A	
SYSOUT.CLASS=B.TYPE=PUNCH	00517000
SYSOUT.CLASS=C	00518000
*	00519000
***** END ASP INITIALIZATION DECK	00601000
*****	00602000
*****	00603000
*	00604000
ENDINISH	00605000
IPL.NAME=SY1.TYPE=MVT	00606000
S=S MT.REGION=36K	
IPL.END	

## APPENDIX B

### AMDAHL Benchmark Log

AMDAHL Benchmark LogThursday, September 4, 1975

- 9:40 Shown machine. IPL showed need for reconfiguration.
- 10:45 Still configuring. They agreed to provide a Testdata tape for our later use.  
I/O errors in NOVA disk. Dropped back to an older system.  
ITEL controller is out. ITEL was notified before we arrived.
- Problems finding manuals -  
Messages and Codes  
OS Utilities  
ASP Manuals
- 11:10 Bringing up AMDAHL system to DASDI the drum. Drum has invalid VOLID. Hardware problem reported to be fixed.
- 11:20 Unsuccessful in cleaning up packs and drum. Hampered due to lack of OS Utilities Manual. Bringing disks would have saved time.
- 11:35 Drum is down.  
Software support brought in.
- 12:05 Go to lunch.  
ITEL work interfered with IPL.
- 2:15 We have the machine.
- 2:50 ASRLIB incorrectly cataloged.
- 3:05 We are up.
- 3:15 Lost interrupt restoring Pack 14.
- 3:30 Interface control check.
- 3:40 Blamed on ITEL controller. Disabled one controller.
- 3:45 Found someone moving packs.
- 4:05 JCL error (lost 15 minutes).

4:10 ASP is up.

No ASP manuals. They said they had them.

4:15 Started STREAM #1. SCR001 was on wrong drive.

4:30 Started STREAM #1 again.

5:15 Finished.

Friday, September 5, 1975

9:05 Mounted packs and tapes.  
ITEL controller reported fixed but has not been tested.  
One bank of 3330's were switched to another machine.

9:40 Lost ITEL controller. IPL without it.

10:00 Up and running.

10:15 Consoles switched - maybe interrupt on 810?

10:25 Restart.

1:15 Mount packs.

1:40 Console switch - press interrupt and it switched back OK.

2:05 Console switch again.

2:28 Channel problem - blew system. Broken toggle on CE channel configurator.

3:00 We got machine back. Toggle fixed.

3:15 Main store bit error (old memory).

3:30 We got it back.

4:10 Completed user jobs.  
Started second run of STREAM #1.

5:30 Completed second run of STREAM #1. Started NRL jobs and last of user jobs.

6:20 Started STREAM #2.

6:45 Lost CRT but 470 kept running.  
Reloaded NOVA and lost nothing.

7:10 Done.

## APPENDIX C

### Description of Current User Jobs Included in the Benchmark

## BIGREBUS/REBUSTST

REBUS is a nuclear reactor fuel cycle management code dominated by a two-dimensional diffusion theory neutronics model. The program is coded primarily in FORTRAN H (OPT=2) with some small assembler language subroutines included for utility functions or performance. The rate determining steps in the code are small loops dominated by double precision floating point multiplication and addition. On the 370/195, this program takes advantage of "loop mode," fast double precision floating point arithmetic, and some overlap of independent floating point operations.

For further information see FRA-TM-62.

### BISONINT

BISON (ANL7271) is a quantum chemical system for the computation of wave-functions, energies, properties, and charge densities of atoms and diatomic molecules using the Hartree Fock self-consistent field method. The time consuming parts of BISON rest in the calculation of numerous integrals by numerical quadrature. These computations are dominated by small loops in which the integrals are assembled as scalar products of pairs of double precision floating point vectors. BISON benefits from the "loop mode" feature of the 370/195 as well as the fast floating point hardware and the high speed buffer storage.

The benchmark problem is an integrals only calculation for HgH at 3.0 bohrs with a 30 X 30 Gaussian grid and a 10 term 50 point Simpson integration. The basis set was 17 X 10 X 5 on Hg and 3 X 5 on H.

DIF1DADJ,DIF1DMOD,DIF1DRL

DIF1D (ANL-7715) is a one-dimensional diffusion theory neutronics model for nuclear reactor design studies. The program is dominated by small loops containing predominantly double precision floating point arithmetic. On the 370/195 this program spends much time in "loop mode" and benefits from the fast floating point hardware.

**FX2DEMO**

FX2 is a program for the study of abnormal transient conditions in fast reactors, including accidents involving reactor material motion and disassembly. The model includes a two-dimensional diffusion theory neutronics calculation and a two-dimensional hydrodynamics model to treat material motion. The program makes heavy use of double precision floating point arithmetic and includes some small subroutines written in assembler code for performance. On the 370/195 this problem benefits from the fast floating point arithmetic and "loop mode."

## NATRAN

NATRAN is a FORTRAN program for the calculation of pressure transients in hydraulic networks using the "method of characteristics." The calculation is dominated by single precision floating point arithmetic and address calculation for triply dimensioned arrays. This program benefits from the overlap of floating point arithmetic on the 370/195.

## OVCBENCH

OVC (ANL-7955) is a quantum chemical computing system for the calculation of multi-configuration self-consistent field wave functions, energies, and properties for atoms, diatomic molecules, and polyatomic molecules. In addition, the program is capable of generating the necessary molecular integrals when Gaussian type expansion basis sets are used. The time consuming paths in the program are the integral generation, which involves much subroutine linkage, indexing, addressing, and floating point arithmetic, and the MCSCF iterations which are dominated by scalar products of double precision floating point vectors.

The benchmark problem is a Gaussian integral and MCSCF calculation for N<sub>02+</sub> with a 4S3p basis on the atoms and 15 configurations and 15 iterations in the MCSCF. On the 370/195, the scalar products (about one half of the CPU time) benefit from "loop mode," fast double precision floating point, overlap in the floating point unit, and the high speed buffer storage.

## SASBENCH

The SAS (ANL-8138) code is an LMFBR accident analysis code that calculates the consequences of a fast reactor accident from the preaccident stage up to the point of large scale fuel motion or disassembly. The program uses double precision floating point arithmetic. However, the large numbers of variable names, arrays, and large common blocks coupled with the use of the FORTRAN G compiler insures a large proportion of fixed point instructions in indexing and addressing functions.

## APPENDIX D

### Description of Tuned Job Kernels Included in the Benchmark

## BITSET

BITSET includes two assembly language subroutines--BITON and BITON1--which allow a FORTRAN program to manipulate individual bits. These routines contain only fixed point, logical, and shifting operations, and represent two versions in a series of tuned codes for this purpose. Both have been tuned for the 370/195 in the sense that sequences of dependent operations and interlocks on register availability for address generation have been avoided. The tuning performed on these routines should provide for high performance on pipelined models of the 360/370 series.

The benchmark problem invokes BITON and BITON1 repeatedly from a FORTRAN driver routine using the FORTRAN CALL statement and includes the linkage overhead associated with that statement.

54  
BITON

CSECT  
USING \*,15  
ST 2,28(0,13)  
L 2,0(0,1)  
L 1,4(0,1)  
L 0,0(0,1)  
S 0,ONE  
  
\*  
SRDL 0,3  
SRL 1,29  
AR 2,0  
A 1,=A(MASK)  
OC 0(1,2),0(1)  
L 2,28(0,13)  
BR 14  
DS 0D  
DC F'1'  
DC X'8040201008040201'  
END

SET BASE REGISTER.  
SAVE REGISTER TWO IN CALLERS SAVEAREA.  
LOAD STARTING ADDRESS OF BIT STRING.  
LOAD ADDRESS OF BIT OFFSET IN STRING.  
LOAD VALUE OF BIT OFFSET IN REG0.  
DECREMENT OFFSET BY 1 TO GET OFFSET  
RELATIVE TO ZERO ORIGIN.  
GET BYTE OFFSET WITHIN STRING. SHIFT  
BIT OFFSET WITHIN BYTE INTO REGISTER 1.  
GET ADDRESS OF BYTE TO BE MODIFIED.  
OBTAIN ADDRESS OF MASK TO TURN ON BIT.  
TURN ON BIT UNDER 1 IN MASK.  
RESTORE REGISTER TWO FOR RETURN.  
RETURN TO CALLING PROGRAM.  
ALIGN CONSTANTS TO DOUBLEWORD BOUNDARY.

BITON1

CSECT  
USING \*,15  
ST 2,28(0,13)  
L 2,0(0,1)  
L 1,4(0,1)  
L 0,0(0,1)  
L 1,SEVEN  
S 0,ONE  
  
\*  
NR 1,0  
SRL 0,3  
A 1,=A(MASK)  
AR 2,0  
OC 0(1,2),0(1)  
L 2,28(0,13)  
BR 14  
DS 0D  
DC F'1'  
DS 0D  
SEVEN DC F'7'  
DS 0D  
MASK DC X'8040201008040201'  
END

SET BASE REGISTER.  
SAVE REGISTER TWO IN CALLERS SAVEAREA.  
LOAD STARTING ADDRESS OF BIT STRING.  
LOAD ADDRESS OF BIT OFFSET IN STRING.  
LOAD VALUE OF BIT OFFSET IN REG0.  
DECREMENT OFFSET BY 1 TO GET OFFSET  
RELATIVE TO ZERO ORIGIN.  
OBTAIN ADDRESS OF MASK TO TURN ON BIT.  
GET ADDRESS OF BYTE TO BE MODIFIED.  
TURN ON BIT UNDER 1 IN MASK.  
RESTORE REGISTER TWO FOR RETURN.  
RETURN TO CALLING PROGRAM.  
ALIGN CONSTANTS TO DOUBLEWORD BOUNDARY.

**DMATMUL/EMATMUL**

DMATMUL and EMATMUL perform floating point matrix multiplication using five different algorithms and ten different matrix dimensions in double and single precision respectively. Varying in the number of explicit matrix indices coded and the number of terms computed within the innermost loop, the algorithms increase in floating point boundedness and in the degree of overlap of floating point operations as the number of matrix indices decreases and the number of terms in the inner loop increases. All of the algorithms execute with their inner loops in "loop mode" on the 370/195.

The algorithms, in order of increasing floating point boundedness and floating point overlap, are:

<u>ALGORITHM</u>	<u>INDICES</u>	<u>TERMS IN INNER LOOP</u>
CRITH	2	1
BRITH	1	1
ERITH	1	2
FRITH	1	2
DRITH	1	4

These algorithms were developed in the course of tuning the SYN3D reactor design and engineering code.

### FORTLIBE/FORTLIBD

FORTLIBE and FORTLIBD invoke respectively single and double precision versions of the frequently executed FORTRAN library functions EXP, LOG, SIN, SQRT, and exponentiation of a floating point number to a floating point power. These routines are optimized for machines unlike the 370/195 and assume that floating point operations are slow, double precision is slower than single precision, normalized arithmetic is slower than unnormalized arithmetic, and no penalty attaches to mixing single and double precision instructions. As these assumptions are all invalid on the 195, these codes are far from optimal on that machine.

FORTLIBE/FORTLIBD were written to sample execution times of selected FORTRAN library functions.

## FSQRT

FSQRT contains two FORTRAN coded double precision routines to compute an array of square roots from an array of arguments and initial guesses using two different four term Newton-Raphson algorithms. The subroutines are in "loop mode" on the 370/195 and make heavy use of floating point double precision arithmetic. There is substantial floating point overlap possible in one of the algorithms.

The square root algorithms were developed while tuning a liquid water molecular dynamics code of Dr. A. Rahman at Argonne.

```
SUBROUTINE FSQRT(ARG,ROOT,N)
IMPLICIT REAL*8 (A-H,O-Z)
```

```
C THIS SUBROUTINE COMPUTES AN ARRAY OF SQUARE ROOTS FROM AN ARRAY
C OF ARGUMENTS USING A FOUR TERM NEWTON RAPHSON ITERATION AND A
C STARTING GUESS SUPPLIED BY THE CALLER. THE STARTING GUESSES ARE
C PLACED IN ARRAY ROOT BEFORE THE CALL AND THE SQUARE ROOTS ARE
C RETURNED IN THE SAME ARRAY ROCT.
```

```
C DIMENSION ARG(1),ROOT(1)
```

```
C DO 100 I = 1, N
RR = ARG (I)
R = .5 * (ROOT (I) + RR / ROOT (I) )
R = RR / R + R
RR = RR + RR
RR = RR + RR
R = RR / R + R
RR = RR + RR
RR = RR + RR
R = RR / R + R
ROOT (I) = .125 * R
100 CONTINUE
RETURN
END
```

```
SUBROUTINE HSQRT(ARG,ROOT,N)
IMPLICIT REAL*8 (A-H,O-Z)
```

```
C THIS SUBROUTINE COMPUTES AN ARRAY OF SQUARE ROOTS FROM AN ARRAY
C OF ARGUMENTS USING A FOUR TERM NEWTON RAPHSON ITERATION AND A
C STARTING GUESS SUPPLIED BY THE CALLER. THE STARTING GUESSES ARE
C PLACED IN ARRAY ROOT BEFORE THE CALL AND THE SQUARE ROOTS ARE
C RETURNED IN THE SAME ARRAY ROCT.
```

```
C DIMENSION ARG(1),ROOT(1)
```

```
C DO 100 I = 1, N
RR = ARG (I)
R = .5 * (ROOT (I) + RR / ROOT (I) )
R = RR / R + R
R = .5 * R
R = RR / R + R
R = .5 * R
R = RR / R + R
ROOT (I) = .5 * R
100 CONTINUE
RETURN
END
```

### MINVERT

MINVERT is a double precision FORTRAN matrix inversion problem (Gauss-Jordan reduction). The inversion subroutine is dominated by two small loops, one of which is floating point dominated and one of which is dominated by address calculation and branching. MINVERT benefits from "loop mode" on the 370/195 and the ability to overlap floating point operations.

MINVERT was written for use in the SYN3D and MC-2 reactor design and engineering codes.

## MORETEST

MORE is an assembly language subroutine to perform a binary search of a large table of single precision floating point numbers. The only floating point operation in the subroutine is floating point compare. Optimization of this program for the 370/195 involved primarily keeping the loops small, separating register modification from register use in addressing, and separating condition code setting instructions from their associated branches.

MOREX

CSECT  
COPY EQUATE  
USING \*,15  
DS 0D  
ST 3,32(13)  
L 3,4(1)  
ST 4,36(13)  
L 4,8(1)  
ST 5,40(13)  
L 5,12(1)  
L 0,=XL4'00FFFFF8'  
L 1,0(1)  
S 1,=F'4'  
L 3,0(3)  
SLL 3,2  
L 4,0(4)  
SLL 4,2  
LE 2,0(5)  
LR 5,3  
AR 5,4  
NR 5,0  
CE 2,0(1,3)  
SRL 5,1  
ST 6,44(13)  
BC LT,INNER  
LR 4,3  
BC 15,RETURN  
CNOP 0,8 PROVIDE DOUBLEWORD ALIGNMENT FOR LOOP MODE  
OUTER DS 0H  
INNER CE 2,0(1,5) TARGET FOR 'QUICK' LOOP.  
LR 6,5  
BC LT,XLT  
AR 5,3  
NR 5,0  
SRL 5,1  
LR 4,6  
BC 15,INNER  
XLT DS 0H  
AR 5,4  
NR 5,0  
CR 6,3  
SRL 5,1  
LR 3,6  
BC NE,OUTER  
RETURN LR 0,4  
SRL 0,2  
RETURN (3,6)  
END

APPENDIX E

**Description of Naval Research Laboratory  
Benchmark Kernels**

**NRLICH01**

NRLICH01 invokes repeatedly a finite Fast Fourier Transform of length 64. The kernel uses single precision floating point and contains several short loops which will fit in "loop mode" on the 370/195. The loops are slowed on the 195 by the existence of addressing interlocks.

This benchmark kernel (minus the driver which invokes it) is reproduced on the next page.

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**NRLICH02**

NRLICH02 invokes a "particle pushing algorithm" and contains a mix of single precision floating point addition, fixed point addressing instructions, and float-to-fixed mode conversion. Some pipelining of floating point addition will be achieved on the 370/195, but overall performance will suffer from the large number of addressing interlocks in the kernel loop.

This kernel (minus its driver) is reproduced on the next page.

SUBROUTINE PUSHXV (IPARTS, NPARTS)

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**NRLICH04**

NRLICH04 is a single precision floating point ordinary differential equation solver using a Runge-Kutta algorithm. The kernel contains many small loops which will execute in "loop mode" on the 370/195, and some overlap of floating point operations will occur.

The kernel (minus its driver) is reproduced on the following page.

**NRLICH05**

NRLICH05 is a two-dimensional mode coupling problem in single precision floating point, using a Runge-Kutta integrator. The loops contain a high proportion of fixed point and branching instructions (logical IF) and suffer reduced performance on the 370/195 due to addressing interlocks.

The kernel (minus its driver) is reproduced on the following pages.



```

C
COMMON * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
COMMON
      INTEGER NOI, NOJ, IMIN, IMAX, JMIN, JMAX
      REAL VP(225,225)
      COMMON NOI, NOJ, IMIN, IMAX, JMIN, JMAX, VP
COMMON
COMMON * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C
C      KERNEL * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * START
C
      REAL D(2,250), DD(2,250)
      INTEGER IPLIM(2,25), JPLIM(2,25)
      INTEGER ICALL
      DATA ICALL /0/
C
C      INITIALIZE ON THE FIRST CALL.
      ICALL = ICALL + 1
      IF (ICALL .EQ. 1) GO TO 50
C
C      THE GAMMA TERMS ARE EVALUATED FIRST.
51    NOK = NEQLST/2
      DO 2 K = 1, NOK
      IF (ABS(D(1,K)) .LT. 1.0E-15) D(1,K) = 0.0
      IF (ABS(D(2,K)) .LT. 1.0E-15) D(2,K) = 0.0
2     CONTINUE
C
C
C      THE LCOP OVER THE VP SUMS FOR THE K + K' TERMS.
      DO 11 I = 1, NOI
      IPMIN = IPLIM(1,I)
      IPMAX = IPLIM(2,I)
      DO 11 J = 1, NOJ
      JPMIN = JPLIM(1,J)
      JPMAX = JPLIM(2,J)
      K = I + NOI*(J-1)
      SUM1 = 0.0
      SUM2 = 0.0
      KPST = IPMIN - 1 - NOI
      KPKPST = K + KPST - 1 + (IMIN + NOI*JMIN)
C
C      THE INNER LOOPS BEGIN HERE.
      DO 12 JP = JPMIN, JPMAX
      KP = KPST + NOI*JP
      KPKP = KPKPST + NOI*JP
      DO 12 IP = IPMIN, IPMAX
      KP = KP + 1
      KPKP = KPKP + 1
C
C      THE TERMS ARE ACCUMULATED IN SUM. MISSING THE FACTOR OF I.
      SUM1 = SUM1 + VP(K,KP)*(D(1,KP)*D(1,KPKP))
      1     + D(2,KP)*D(2,KPKP))
12    SUM2 = SUM2 + VP(K,KP)*(D(1,KP)*D(2,KPKP))
      1     - D(2,KP)*D(1,KPKP))
C
C      THE DERIVATIVES ARE UPDATED USING SUM. NOTE THE FACTOR OF I.
      DD(1,K) = - SUM2
11    DD(2,K) = SUM1
C
C      THE VALUE OF THE DERIVATIVES ARE LIMITED.

```



### NRLICH06

NRLICH06 is a hydrodynamics calculation using an FCT algorithm coded in single precision floating point. The kernel contains many small loops that will operate in "loop mode" on the 370/195 and achieve some overlap in the floating point unit.

The kernel (minus its driver) is reproduced on the following page.

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SUBROUTINE SHASTX (X, XC, R1, V, ISEP, DT, NX, MODE)

**NRLICH07**

NRLICH07 is a floating point matrix and vector arithmetic exerciser. Single and double precision are used equally, but they are never mixed in the same expression. Most of the work is in "loop mode" on the 370/195, and much overlap of floating point multiply and add should be achieved.

The entire kernel (including driver) is reproduced in the following pages.

```

C      NRL BENCHMARK TEST 7(F)          MATRICES AND VECTORS
C      JAY PAUL BORIS                 NAVAL RESEARCH LAB CODE 7706
C      WASHINGTON, D.C.              202 - 767 - 3142
C
C      REAL      T(104,104), S(104,104), U(104,104), A(104), B(104),
1      C(104), RAND(208)
1      DOUBLE PRECISION TD(104,104), SD(104,104), UD(104,104),
1      AD(104), BD(104), CD(104), FACTD, RANDD(208)
1      INTEGER   IRAND(107)
1000    FORMAT (I6, F12.5)
1001    FORMAT ('1NRL BENCHMARK TEST 7 - MATRICES AND VECTORS ',
1      /, 5X, 'NSTEP = ', I6, 5X, ' AND DATUM = ', F12.5, //)
1002    FORMAT (3X, 8D14.6)
1003    FORMAT ('0AT STEP ', I5, ' C AND CD ARE ')
1004    FORMAT (3X, 8E14.6)
1005    FORMAT (1X, /)
C      THE FIRST 107 RANDOM NUMBERS FROM THE A&S RANDOM DIGIT TABLES.
DATA IRAND /53479,81115,98036,12217,59526,40238,40577,39351,
1      43211,69255,97344,70328,58116,91964,26240,44643,83287,
2      97391,92823,77578,66023,38277,74523,71118,84892,13956,
3      98899,92315,65783,59640,99776,75723,03172,43112,83086,
4      81982,14538,26162,24899,20551,30176,48979,92153,38416,
5      42436,26636,83903,44722,69210,69117,81874,83339,14988,
6      99937,13213,30177,47967,93793,86693,98854,19839,90630,
7      71836,95053,55532,60908,84108,55342,48479,63799,09337,
8      33435,53869,52769,18001,25820,96198,66518,78314,97013,
9      31151,58295,40823,41330,21093,93882,49192,44876,47185,
A      81425,67619,52515,03037,81699,17106,64982,60834,85319,
B      47814,08075,61946,48790,11602,83043,22257,11832,04344/
RANDOM(I) = 1.0E-5*FLOAT(IRAND(I+1))

C      INITIALIZE THE PROGRAM. DATUM RESTRICTED TO THE RANGE 0.0 TO 1.0.
C      IF DATUM > .9, THE TWO SOLUTIONS, DOUBLE AND SINGLE, ARE THE SAME.
      READ (5, 1000) NSTEP, DATUM
      WRITE (6, 1001) NSTEP, DATUM
      II = 0
      IF (DATUM .GT. 0.90) II = 1
      II1 = II + 1
      DO 1 I = 1, 104
      A(I) = 1.0
      AD(I) = 1.0
      B(T) = 1.0
      BD(I) = 1.0
      IRANDX = MOD(2*I-1, 107)
      RAND(2*I-1) = RANDOM(IRANDX)
      IRANDX = MOD(2*I, 107)
      RAND(2*I) = RANDOM(IRANDX)
      RANDD(2*I-1) = RAND(2*I-1)
      RANDD(2*I) = RAND(2*I)
      DO 1 J = 1, 104
      IJ = T + 104*(J-1)
      IRANDX = MOD(IJ+II, 107)
      T(I,J) = RANDOM(IRANDX)
      IRANDX = MOD(IJ+II1, 107)
      TD(I,J) = RANDOM(IRANDX)
      IRANDX = MOD(IJ+II2, 107)
      SD(I,J) = -0.5*(RANDOM(IRANDX) + DATUM)
      IRANDX = MOD(IJ+II3, 107)
      1     SD(I,J) = -0.5*(RANDOM(IRANDX) + DATUM)

C      THE LOOP OVER STEPS IS BEGIN.
      DO 100 NSTEP = 1, NSTEP

```

C THE CALCULATIONS ARE BEGUN.

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## APPENDIX F

Detailed Results For All Benchmark Job Groups

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT		CPU	WAIT
<hr/>									
BMKJS01A	4	1.82	38.82	4	2.16	33.79		0.841	1.149
BMKJS02A	3	2.51	32.92	3	3.16	28.19		0.792	1.168
BMKJS03A	1	8.57	19.95	1	8.29	18.91		1.034	1.055
BMKJS03B	1	5.09	6.85	1	4.99	9.45		1.020	0.725
BMKJS04A	2	87.68	21.12	2	89.66	21.22		0.978	0.995
BMKJS05A	1	68.88	23.02	1	39.41	11.59		1.748	1.986
BMKJS06A	1	3.98	15.31	1	4.76	11.59		0.836	1.321
BMKJS06B	1	3.66	19.10	1	3.80	18.27		0.963	1.045
BMKJS07A	3	0.88	13.77	3	1.07	9.66		0.825	1.426
BMKJS07B	1	1.06	19.85	1	1.18	15.25		0.898	1.302
PMKJS08A	1	1.29	8.92	1	1.53	8.09		0.843	1.103
BMKJS08B	1	1.24	20.27	1	1.57	7.88		0.790	2.572
BMKJS09A	1	14.43	214.56	1	13.10	520.09		1.102	0.413
BMKJS09B	1	10.24	151.98	1	10.59	452.48		0.967	0.336
BMKJS10A	2	0.75	8.05	2	0.95	7.28		0.785	1.106
BMKJS10B	2	0.71	7.70	2	0.90	9.01		0.789	0.855
BMKJS11A	1	11.01	16.74	1	11.78	11.59		0.935	1.444
PMKJS11B	1	9.27	9.87	1	9.21	15.73		1.007	0.627
BMKJS12A	1	25.90	71.59	1	28.23	76.68		0.917	0.934
BMKJS13A	1	3.85	31.81	1	4.24	56.85		0.908	0.560
BMKJS13B	1	3.14	26.94	1	3.67	36.35		0.856	0.741
BMKJS14A	1	164.91	64.07	1	106.83	35.20		1.544	1.820
BMKJS15A	1	13.20	23.37	1	16.65	24.98		0.793	0.936
BMKJS15B	1	6.54	30.63	1	7.62	38.95		0.858	0.786
BMKJS16A	1	12.45	28.09	1	14.24	22.50		0.874	1.248
BMKJS17A	1	26.26	58.23	1	31.21	35.29		0.841	1.650
BMKJS18A	1	101.61	17.53	1	42.95	11.04		2.366	1.588
BMKJS19A	1	128.41	76.25	1	130.91	69.89		0.981	1.091
BMKJS19B	1	89.77	54.55	1	88.77	41.08		1.011	1.328
BMKJS20A	1	4.07	16.20	1	5.06	13.56		0.804	1.195
BMKJS21A	3	2.80	58.83	3	3.10	65.25		0.904	0.902
BMKJS21B	7	0.20	4.43	7	0.22	5.69		0.914	0.779
BMKJS22A	1	24.75	87.56	1	32.39	107.27		0.764	0.816
BMKJS23A	1	1.09	5.59	1	1.27	7.49		0.858	0.746
BMKJS23B	1	1.22	9.91	1	1.39	10.30		0.878	0.962
BMKJS24A	1	123.36	187.04	1	146.90	149.85		0.840	1.248
BMKJS24B	1	4.90	23.55	1	5.63	19.40		0.870	1.214
COMPMOVE	1	0.43	20.63	1	0.52	13.46		0.827	1.533
COPY1	1	1.30	118.99	1	1.34	119.00		0.970	1.000
COPY2	1	0.10	2.37	1	0.10	2.80		1.000	0.846
GENER1	5	0.23	19.44	5	0.23	26.68		1.027	0.729
GENER2	7	0.11	3.87	7	0.12	8.10		0.885	0.478
GENUPDTE	3	0.45	5.58	3	0.46	4.68		0.971	1.193
LIST1	3	0.24	5.43	3	0.22	4.07		1.076	1.334
LIST2	3	0.20	5.61	3	0.20	5.55		1.034	1.010
LIST3	2	0.59	21.58	2	0.53	19.67		1.103	1.097

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LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018
UTILITY1	1	0.58	16.43	1	0.68	11.27	0.853	1.458
-----*								
TOTAL	105	1092.07	2450.62	105	1006.22	2943.19	1.085	0.833
MEAN	60	16.30	30.39	60	14.77	38.49	0.963	1.181

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM							
STEP = ASM															
<hr/>															
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
BMKJS13A	2	0.65	9.15	2	0.70	23.00		0.929	0.398						
BMKJS13B	2	0.62	9.54	2	0.71	13.74		0.873	0.694						
BMKJS19A	2	0.64	13.12	2	0.75	14.95		0.860	0.877						
BMKJS21A	39	0.22	4.53	39	0.24	5.02		0.904	0.902						
BMKJS21B	7	0.20	4.43	7	0.22	5.69		0.914	0.779						
TOTAL	52	13.62	271.14	52	15.13	339.00		0.900	0.800						
MEAN	5	0.47	8.15	5	0.52	12.48		0.896	0.730						
<hr/>															
STEP = EDT															
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
BMKJS01A	8	0.34	13.74	8	0.41	11.29		0.819	1.217						
BMKJS02A	3	0.51	16.58	3	0.67	14.99		0.760	1.106						
BMKJS03A	2	0.17	7.07	2	0.21	6.85		0.833	1.033						
BMKJS04A	4	0.18	7.22	4	0.22	6.80		0.778	1.061						
BMKJS05A	1	0.16	5.22	1	0.20	3.16		0.800	1.652						
BMKJS06A	1	0.23	11.51	1	0.27	6.91		0.852	1.666						
BMKJS07A	3	0.18	6.49	3	0.19	4.37		0.947	1.485						
BMKJS09A	1	0.17	5.48	1	0.20	3.73		0.850	1.469						
BMKJS10A	2	0.12	3.20	2	0.15	2.97		0.742	1.077						
BMKJS11A	1	0.18	10.77	1	0.22	7.23		0.818	1.490						
BMKJS12A	1	0.55	11.97	1	0.58	12.63		0.948	0.948						
BMKJS13A	1	0.25	5.13	1	0.24	6.65		1.042	0.771						
BMKJS14A	1	0.40	15.58	1	0.43	9.56		0.930	1.630						
BMKJS15A	1	0.42	16.05	1	0.49	12.65		0.857	1.269						
BMKJS15B	1	0.49	11.80	1	0.52	23.30		0.942	0.506						
BMKJS16A	1	0.22	4.98	1	0.25	6.92		0.880	0.720						
BMKJS17A	1	0.55	15.20	1	0.49	11.06		1.122	1.374						
BMKJS18A	1	0.17	6.42	1	0.19	4.02		0.895	1.597						
BMKJS19A	1	0.41	11.50	1	0.55	12.11		0.745	0.950						
BMKJS19B	1	0.50	15.29	1	0.64	16.52		0.781	0.926						
BMKJS20A	1	0.29	6.72	1	0.37	5.46		0.784	1.231						
TOTAL	37	11.05	382.16	37	13.16	337.13		0.840	1.134						
MEAN	21	0.31	9.90	21	0.36	9.01		0.863	1.199						

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM							
STEP = FTG															
<hr/>															
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
BMKJS02A	3	0.30	2.10	3	0.37	2.12		0.811	0.994						
BMKJS03A	1	1.39	2.63	1	1.84	2.11		0.755	1.246						
BMKJS03B	1	1.35	1.87	1	1.81	3.38		0.746	0.553						
BMKJS04A	2	1.14	1.59	2	1.49	2.55		0.766	0.625						
BMKJS06A	1	2.69	1.56	1	3.38	2.19		0.796	0.712						
BMKJS07A	3	0.47	1.92	3	0.60	1.53		0.778	1.255						
BMKJS10A	2	0.46	1.31	2	0.63	1.24		0.736	1.060						
BMKJS10B	2	0.46	1.55	2	0.61	2.10		0.756	0.740						
BMKJS11A	1	2.59	2.82	1	3.31	2.10		0.782	1.343						
BMKJS15A	1	11.16	4.52	1	14.43	7.13		0.773	0.634						
TOTAL	17	25.62	34.39	17	33.15	39.62		0.773	0.868						
MEAN	10	2.20	2.19	10	2.85	2.64		0.770	0.916						

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = FTH									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS05A	1	2.45	11.15	1	3.13	5.76	0.783	1.936	
BMKJS06B	1	0.88	3.17	1	1.07	2.70	0.822	1.174	
BMKJS07B	1	0.54	7.17	1	0.64	4.99	0.844	1.437	
BMKJS08A	1	0.38	5.31	1	0.43	1.72	0.884	3.087	
BMKJS08B	1	0.34	2.32	1	0.44	3.04	0.773	0.763	
BMKJS09A	1	0.69	1.40	1	0.84	2.95	0.821	0.475	
BMKJS09B	1	0.72	4.68	1	0.83	2.66	0.867	1.759	
BMKJS11B	1	1.48	2.35	1	1.75	4.74	0.846	0.496	
BMKJS12A	1	23.10	56.93	1	27.34	61.92	0.845	0.919	
BMKJS13A	1	0.85	3.43	1	0.98	1.96	0.867	1.750	
BMKJS13B	1	0.81	2.26	1	0.95	1.73	0.853	1.306	
BMKJS14A	1	10.98	43.53	1	13.43	22.57	0.818	1.929	
BMKJS15B	1	6.03	18.73	1	7.07	15.55	0.853	1.205	
BMKJS16A	1	6.60	16.25	1	8.01	12.00	0.824	1.354	
BMKJS17A	1	19.63	41.02	1	23.61	21.59	0.831	1.900	
BMKJS18A	1	2.01	4.89	1	2.38	5.13	0.845	0.953	
BMKJS19A	1	5.34	32.76	1	6.18	22.56	0.864	1.452	
BMKJS19B	1	4.95	30.14	1	5.93	19.54	0.835	1.542	
BMKJS20A	1	3.67	8.24	1	4.55	6.84	0.807	1.205	
BMKJS23A	1	0.90	1.92	1	1.05	3.32	0.857	0.578	
BMKJS23B	1	0.93	3.94	1	1.06	2.64	0.877	1.492	
BMKJS24A	1	1.66	6.83	1	1.96	4.77	0.847	1.432	
BMKJS24B	1	1.63	11.54	1	1.91	4.73	0.853	2.440	
TOTAL	23	96.57	319.96	23	115.54	235.41	0.836	1.359	
MEAN	23	4.20	13.91	23	5.02	10.24	0.840	1.417	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

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STEP = GO				AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
BMKJS01A	12	0.07	1.18	12	0.08	1.18		0.888	1.001						
BMKJS02A	9	0.11	2.34	9	0.12	1.92		0.891	1.214						
BMKJS03A	4	1.71	0.79	4	1.51	0.78		1.133	1.023						
BMKJS04A	6	28.73	1.69	6	29.24	1.69		0.983	1.003						
BMKJS05A	3	22.09	2.22	3	12.03	0.89		1.837	2.491						
BMKJS06A	3	0.35	0.75	3	0.37	0.83		0.955	0.900						
BMKJS07A	12	0.06	1.34	12	0.07	0.94		0.843	1.426						
BMKJS09A	3	4.52	69.23	3	4.02	171.14		1.125	0.405						
BMKJS10A	6	0.06	1.18	6	0.06	1.02		1.000	1.151						
BMKJS11A	3	2.75	1.05	3	2.75	0.75		0.999	1.394						
BMKJS12A	2	1.12	1.34	2	0.15	1.06		7.258	1.263						
BMKJS13A	3	0.48	1.65	3	0.54	0.74		0.894	2.220						
BMKJS14A	2	76.76	2.48	2	46.48	1.53		1.651	1.616						
BMKJS15A	3	0.54	0.93	3	0.58	1.73		0.936	0.538						
BMKJS15B	1	0.02	0.10	1	0.03	0.10		0.667	1.000						
BMKJS16A	4	1.41	1.71	4	1.49	0.89		0.941	1.916						
BMKJS17A	2	3.04	1.00	2	3.55	1.32		0.855	0.761						
BMKJS18A	3	33.14	2.07	3	13.46	0.63		2.462	3.291						
BMKJS19A	3	40.46	1.92	3	40.89	1.77		0.989	1.083						
BMKJS19B	2	42.16	4.56	2	41.10	2.51		1.026	1.817						
BMKJS20A	3	0.04	0.41	3	0.05	0.42		0.786	0.984						
TOTAL	89	747.05	338.08	89	597.36	615.37		1.251	0.549						
MEAN	21	12.36	4.76	21	9.46	9.23		1.387	1.357						

STEP = IEBCOMPR				AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT						
COMPMOVE	1	0.07	2.25	1	0.08	1.41		0.875	1.596						
TOTAL	1	0.07	2.25	1	0.08	1.41		0.875	1.596						
MEAN	1	0.07	2.25	1	0.08	1.41		0.875	1.596						

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 MODEL JOBSTREAM

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AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

STEP = IEBUPDTE

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
GENUPDTE	3	0.38	4.57	3	0.39	3.52	0.966	1.300
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018
TOTAL	11	2.24	37.70	11	2.39	28.05	0.937	1.344
MEAN	7	0.17	3.35	7	0.19	2.27	0.886	1.455

STEP = IEHLIST

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328
TOTAL	13	3.46	148.93	13	3.47	122.03	0.997	1.220
MEAN	5	0.29	13.12	5	0.29	10.77	0.972	1.236

STEP = IEHMOVE

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COMPMOVE	1	0.36	18.38	1	0.44	12.05	0.818	1.525
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935
UTILITY1	1	0.31	11.49	1	0.37	7.57	0.838	1.518
TOTAL	5	1.62	69.70	5	1.80	33.19	0.900	2.100
MEAN	3	0.33	14.38	3	0.38	8.05	0.872	1.993

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

STEP = IEBUTIL

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COMPMOVE	1	0.07	2.25	1	0.08	1.41	0.875	1.596
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478
GENUPDTE	3	0.38	4.57	3	0.39	3.52	0.966	1.300
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018
TOTAL	33	6.87	308.10	33	7.11	363.84	0.966	0.847
MEAN	16	0.23	11.48	16	0.24	11.82	0.949	1.205

STEP = IEHUTIL

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COMPMOVE	1	0.36	18.38	1	0.44	12.05	0.818	1.525
GENUPDTE	3	0.07	1.01	3	0.07	1.16	1.000	0.868
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935
UTILITY1	5	0.12	3.29	5	0.14	2.25	0.853	1.458
TOTAL	25	5.56	226.60	25	5.79	162.41	0.960	1.395
MEAN	9	0.26	11.28	9	0.27	8.20	0.944	1.441

**ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM**

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = UTILITY									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
COMPMOVE	2	0.21	10.31	2	0.26	6.73	0.827	1.533	
COPY1	1	1.30	118.99	1	1.34	119.00	0.970	1.000	
COPY2	1	0.10	2.37	1	0.10	2.80	1.000	0.846	
GENER1	5	0.23	19.44	5	0.23	26.68	1.027	0.729	
GENER2	7	0.11	3.87	7	0.12	8.10	0.885	0.478	
GENUPDTE	6	0.22	2.79	6	0.23	2.34	0.971	1.193	
LIST1	3	0.24	5.43	3	0.22	4.07	1.076	1.334	
LIST2	3	0.20	5.61	3	0.20	5.55	1.034	1.010	
LIST3	2	0.59	21.58	2	0.53	19.67	1.103	1.097	
LIST4	3	0.11	6.68	3	0.14	4.73	0.786	1.412	
LIST5	2	0.31	26.31	2	0.36	19.81	0.863	1.328	
MOVE1	3	0.32	13.28	3	0.33	4.52	0.960	2.935	
PTPCH1	1	0.20	1.52	1	0.18	1.39	1.111	1.094	
PTPCH2	2	0.14	3.46	2	0.13	2.10	1.115	1.646	
UPDAT1	3	0.18	2.88	3	0.19	2.59	0.947	1.112	
UPDAT2	1	0.20	5.40	1	0.19	9.09	1.053	0.594	
UPDTE1	1	0.08	4.31	1	0.11	2.76	0.727	1.562	
UPDTE2	2	0.09	3.12	2	0.13	3.18	0.760	0.983	
UPDTE3	1	0.04	0.21	1	0.04	0.99	1.000	0.212	
UPDTE4	1	0.35	3.00	1	0.34	1.30	1.029	2.308	
UPDTE5	1	0.09	6.30	1	0.13	2.25	0.692	2.800	
UPDTE6	2	0.18	1.96	2	0.18	1.93	1.029	1.018	
UTILITY1	5	0.12	3.29	5	0.14	2.25	0.853	1.458	
*****									
TOTAL	58	12.43	534.70	58	12.90	526.25	0.964	1.016	
MEAN	23	0.24	11.83	23	0.25	11.04	0.949	1.290	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TOTALS

STEPNAME	STEPS	CPU	WAIT			CPU	WAIT		
				STEPS	CPU			CPU	WAIT
<hr/>									
ASM	52	0.26	5.21	52	0.29	6.52	0.900	0.800	
EDT	37	0.30	10.33	37	0.36	9.11	0.840	1.134	
FTG	17	1.51	2.02	17	1.95	2.33	0.773	0.868	
FTH	23	4.20	13.91	23	5.02	10.24	0.836	1.359	
GO	89	8.39	3.80	89	6.71	6.91	1.251	0.549	
IEBCOMPR	1	0.07	2.25	1	0.08	1.41	0.875	1.596	
IEBCOPY	2	0.70	60.68	2	0.72	60.90	0.972	0.996	
IEBGENER	12	0.16	10.36	12	0.17	15.84	0.965	0.654	
IEBPTPCH	3	0.16	2.82	3	0.15	1.87	1.114	1.509	
IEBUPDAT	4	0.18	3.51	4	0.19	4.21	0.974	0.833	
IEBUPDTE	11	0.20	3.43	11	0.22	2.55	0.937	1.344	
IEHLIST	13	0.27	11.46	13	0.27	9.39	0.997	1.220	
IEHMOVE	5	0.32	13.94	5	0.36	6.64	0.900	2.100	
IEHPROGM	7	0.07	1.14	7	0.07	1.03	0.923	1.108	
LOAD&GO	34	4.94	14.44	34	5.77	22.54	0.857	0.641	
PL1	8	2.20	9.88	8	2.85	10.49	0.773	0.942	
<hr/>									
TOTAL	318	1092.08	2450.62	318	1006.23	2943.19	1.085	0.833	
MEAN	16	1.50	10.57	16	1.57	10.75	0.930	1.103	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

## SUMMARY OF STEP MEANS

STEPNAME	JOBS	CPU	WAIT				CPU	WAIT
				JOBS	CPU	WAIT		
ASM	5	0.47	8.15	5	0.52	12.48	0.896	0.730
EDT	21	0.31	9.90	21	0.36	9.01	0.863	1.199
FTG	10	2.20	2.19	10	2.85	2.64	0.770	0.916
FTH	23	4.20	13.91	23	5.02	10.24	0.840	1.417
GO	21	12.36	4.76	21	9.46	9.23	1.387	1.357
IEBCOMPRESS	1	0.07	2.25	1	0.08	1.41	0.875	1.596
IEBCOPY	2	0.70	60.68	2	0.72	60.90	0.985	0.923
IEBGENER	2	0.17	11.66	2	0.18	17.39	0.956	0.603
IERPPTPCH	2	0.17	2.49	2	0.15	1.75	1.113	1.370
IEBUPDAT	2	0.19	4.14	2	0.19	5.84	1.000	0.853
IEBUPDTE	7	0.17	3.35	7	0.19	2.27	0.886	1.455
IFHLIST	5	0.29	13.12	5	0.29	10.77	0.972	1.236
IEHMOVE	3	0.33	14.38	3	0.38	8.05	0.872	1.993
IEHPROGM	2	0.07	1.12	2	0.07	1.04	0.935	1.102
LOAD&GO	14	5.86	16.82	14	6.86	26.60	0.910	1.046
PL1	3	4.04	13.73	3	5.35	16.74	0.791	1.026
TOTAL	123	487.51	1261.80	123	471.47	1399.06	1.034	0.902
MEAN	16	1.98	11.42	16	2.04	12.27	0.941	1.176

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
BMKJSMP1	1	174.77	7.64	1	249.11	5.17	0.702	1.478
BMKJS01A	4	1.80	36.69	4	2.17	35.33	0.831	1.038
BMKJS02A	3	2.50	31.46	3	3.18	30.13	0.785	1.044
BMKJS03A	1	8.63	15.85	1	8.05	15.44	1.072	1.027
BMKJS03B	1	5.22	5.28	1	4.95	4.31	1.055	1.225
BMKJS04A	2	98.34	20.48	2	71.83	21.92	1.369	0.934
BMKJS05A	5	67.25	12.44	5	39.64	10.52	1.697	1.182
BMKJS06A	1	3.92	16.69	1	4.79	12.83	0.818	1.301
BMKJS06B	1	3.69	17.34	1	3.76	11.44	0.981	1.516
BMKJS07A	3	0.84	11.53	3	1.07	10.38	0.786	1.111
BMKJS07B	1	1.04	16.45	1	1.17	14.37	0.889	1.145
BMKJS08A	1	1.26	9.23	1	1.54	7.88	0.818	1.171
BMKJS08B	1	1.30	7.74	1	1.54	8.67	0.844	0.893
BMKJS09A	1	14.25	520.20	1	15.24	588.53	0.935	0.884
BMKJS09B	1	9.98	466.03	1	10.65	390.21	0.937	1.194
BMKJS10A	2	0.80	7.80	2	0.96	6.70	0.833	1.163
BMKJS10B	2	0.74	7.05	2	0.89	8.13	0.831	0.867
BMKJS11A	1	10.65	11.66	1	11.76	12.02	0.906	0.970
BMKJS11B	1	9.28	6.64	1	9.06	12.44	1.024	0.534
BMKJS12A	1	25.71	68.95	1	28.07	59.44	0.916	1.160
BMKJS13A	1	3.70	35.40	1	4.34	38.15	0.853	0.928
BMKJS13B	1	3.15	27.04	1	3.65	26.79	0.863	1.009
BMKJS14A	1	157.82	36.47	1	104.19	34.95	1.515	1.043
BMKJS15A	1	12.71	13.73	1	15.71	9.59	0.809	1.432
BMKJS15B	1	6.53	47.84	1	7.67	37.18	0.851	1.287
BMKJS16A	1	12.12	23.78	1	14.12	19.72	0.858	1.206
BMKJS17A	1	25.96	53.37	1	30.78	37.14	0.843	1.437
BMKJS18A	1	97.53	7.19	1	42.11	7.85	2.316	0.916
BMKJS19A	1	128.70	58.18	1	129.43	62.12	0.994	0.937
BMKJS19B	5	85.69	37.35	5	87.51	32.03	0.979	1.166
BMKJS20A	1	4.01	13.23	1	4.94	10.96	0.812	1.207
BMKJS21A	3	2.88	43.54	3	3.09	48.75	0.931	0.893
BMKJS21B	7	0.21	3.29	7	0.21	4.53	0.980	0.727
BMKJS22A	1	25.45	56.96	1	32.49	120.44	0.783	0.473
BMKJS23A	1	1.09	5.45	1	1.24	4.72	0.879	1.155
BMKJS23B	1	1.15	11.67	1	1.35	7.06	0.852	1.653
BMKJS24A	1	124.29	159.39	1	147.63	153.92	0.842	1.036
BMKJS24B	1	4.91	13.47	1	5.68	18.96	0.864	0.710
COMPMOVE	1	0.48	16.54	1	0.52	13.79	0.923	1.199
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875
DMATMUL	1	252.57	13.02	1	94.48	13.99	2.673	0.931
EMATMUL	1	145.18	11.51	1	91.32	13.02	1.590	0.884
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995
GENUPDTE	3	0.45	5.80	3	0.46	3.98	0.978	1.456

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LIST1	3	0.22	5.86	3	0.23	4.20	1	0.971	1.395
LIST2	3	0.20	5.96	3	0.20	4.97	1	1.000	1.200
LIST3	2	0.52	20.91	2	0.54	18.39	1	0.954	1.137
LIST4	3	0.14	5.19	3	0.14	4.17	1	1.024	1.244
LIST5	2	0.31	24.94	2	0.35	17.10	1	0.873	1.458
MOVE1	3	0.35	13.81	3	0.34	5.48	1	1.010	2.518
NATRAN	1	94.43	19.62	1	86.53	15.95	1	1.091	1.230
PTPCH1	1	0.18	3.10	1	0.18	1.40	1	1.000	2.214
PTPCH2	2	0.12	2.28	2	0.13	2.35	1	0.962	0.972
UPDAT1	3	0.18	2.86	3	0.19	2.93	1	0.948	0.975
UPDAT2	1	0.26	4.21	1	0.20	8.97	1	1.300	0.469
UPDTE1	1	0.13	2.84	1	0.12	3.04	1	1.083	0.934
UPDTE2	2	0.10	3.18	2	0.13	2.99	1	0.808	1.063
UPDTE3	1	0.04	0.46	1	0.05	0.22	1	0.800	2.091
UPDTE4	1	0.34	3.34	1	0.35	1.75	1	0.971	1.909
UPDTE5	1	0.10	5.26	1	0.12	2.44	1	0.833	2.156
UPDTE6	2	0.18	1.91	2	0.17	1.69	1	1.029	1.127
UTILITY1	1	0.54	19.82	1	0.68	11.14	1	0.794	1.779
TOTAL	117	2375.43	3036.86	117	1995.79	3020.54	1	1.190	1.005
MEAN	64	25.61	35.18	64	21.64	35.19	1	1.007	1.166

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

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**AMDAHL 470V/6**      **IBM 370/195**      **AMDAHL / IBM**

STEP = ASM

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
BMKJS13A	2	0.63	11.11	2	0.72	13.66	0.882	0.813
BMKJS13B	2	0.61	10.95	2	0.70	9.64	0.871	1.136
BMKJS19A	2	0.65	8.93	2	0.74	10.98	0.879	0.813
BMKJS21A	39	0.22	3.35	39	0.24	3.75	0.931	0.893
BMKJS21B	7	0.21	3.29	7	0.21	4.53	0.980	0.727
TOTAL	52	13.88	215.65	52	15.08	246.55	0.920	0.875
MEAN	5	0.47	7.53	5	0.52	8.51	0.909	0.876

STEP = EDT

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
BMKJS01A	8	0.35	13.33	8	0.41	12.35	0.840	1.079
BMKJS02A	3	0.49	16.40	3	0.67	15.53	0.735	1.056
BMKJS03A	2	0.19	6.72	2	0.20	6.23	0.902	1.080
BMKJS04A	4	0.18	6.92	4	0.22	7.59	0.800	0.911
BMKJS05A	5	0.14	3.80	5	0.19	3.38	0.758	1.126
BMKJS06A	1	0.21	8.66	1	0.28	8.70	0.750	0.995
BMKJS07A	3	0.15	4.55	3	0.19	4.21	0.789	1.082
BMKJS09A	1	0.19	6.16	1	0.20	5.36	0.950	1.149
BMKJS10A	2	0.14	3.63	2	0.15	2.91	0.903	1.247
BMKJS11A	1	0.17	8.38	1	0.23	6.59	0.739	1.272
BMKJS12A	1	0.57	25.66	1	0.67	12.96	0.851	1.980
BMKJS13A	1	0.22	7.13	1	0.26	6.04	0.846	1.180
BMKJS14A	1	0.42	7.12	1	0.42	10.56	1.000	0.674
BMKJS15A	1	0.36	9.94	1	0.47	6.45	0.766	1.541
BMKJS15B	1	0.48	18.62	1	0.51	23.97	0.941	0.777
BMKJS16A	1	0.21	6.49	1	0.26	6.24	0.808	1.040
BMKJS17A	1	0.48	17.84	1	0.59	13.26	0.814	1.345
BMKJS18A	1	0.19	2.28	1	0.19	2.39	1.000	0.954
BMKJS19A	1	0.44	9.69	1	0.57	13.57	0.772	0.714
BMKJS19R	5	0.48	10.58	5	0.63	11.34	0.759	0.933
BMKJS20A	1	0.30	5.38	1	0.36	4.55	0.833	1.182
TOTAL	45	13.44	423.11	45	16.63	400.88	0.808	1.055
MEAN	21	0.30	9.49	21	0.37	8.77	0.836	1.110

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = FTG									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS02A	3	0.30	2.48	3	0.38	2.50	0.805	0.992	
BMKJS03A	1	1.38	0.96	1	1.82	1.55	0.758	0.619	
BMKJS03B	1	1.40	1.22	1	1.77	0.85	0.791	1.435	
BMKJS04A	2	1.08	1.63	2	1.52	1.78	0.714	0.913	
BMKJS06A	1	2.73	3.09	1	3.40	1.93	0.803	1.601	
BMKJS07A	3	0.47	1.94	3	0.60	1.98	0.785	0.978	
BMKJS10A	2	0.49	2.08	2	0.63	0.95	0.770	2.195	
BMKJS10B	2	0.48	1.90	2	0.61	1.78	0.795	1.067	
BMKJS11A	1	2.53	1.56	1	3.27	3.13	0.774	0.498	
BMKJS15A	1	10.77	1.29	1	13.58	0.90	0.793	1.433	
TOTAL	17	25.25	32.60	17	32.30	30.83	0.782	1.057	
MEAN	10	2.16	1.82	10	2.76	1.74	0.779	1.173	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

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ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = GO									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
BMKJS01A	12	0.07	1.10	12	0.08	1.19	0.845	0.923	
BMKJS02A	9	0.10	1.94	9	0.12	1.91	0.844	1.017	
BMKJS03A	4	1.72	0.36	4	1.45	0.36	1.182	1.007	
BMKJS04A	6	32.30	1.67	6	23.29	1.65	1.387	1.012	
BMKJS05A	15	21.55	0.97	15	12.13	0.78	1.777	1.246	
BMKJS06A	3	0.33	1.65	3	0.37	0.73	0.883	2.245	
BMKJS07A	12	0.05	1.26	12	0.07	1.05	0.786	1.202	
BMKJS09A	3	4.46	170.60	3	4.74	193.77	0.940	0.880	
BMKJS10A	6	0.06	0.69	6	0.06	0.95	1.000	0.733	
BMKJS11A	3	2.65	0.57	3	2.75	0.77	0.962	0.748	
BMKJS12A	2	1.18	0.93	2	0.15	1.06	7.613	0.878	
BMKJS13A	3	0.45	0.45	3	0.55	0.85	0.829	0.533	
BMKJS14A	2	73.40	0.65	2	45.30	0.89	1.620	0.736	
BMKJS15A	3	0.53	0.83	3	0.55	0.75	0.952	1.116	
BMKJS15B	1	0.02	0.13	1	0.02	0.06	1.000	2.167	
BMKJS16A	4	1.37	0.88	4	1.49	0.58	0.918	1.513	
BMKJS17A	2	2.99	1.09	2	3.55	1.32	0.841	0.830	
BMKJS18A	3	31.81	0.30	3	13.18	0.46	2.413	0.657	
BMKJS19A	3	40.54	1.22	3	40.36	1.45	1.004	0.839	
BMKJS19B	10	40.15	1.59	10	40.55	1.33	0.990	1.194	
BMKJS20A	3	0.05	0.34	3	0.04	0.37	1.077	0.919	
TOTAL	109	1331.23	628.89	109	1027.89	692.50	1.295	0.908	
MEAN	21	12.18	9.01	21	9.09	10.11	1.422	1.066	

STEP = IEBCOMPR									
*****									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
*****									
COMPMOVE	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
TOTAL	1	0.09	1.26	1	0.09	1.79	1.000	0.704	
MEAN	1	0.09	1.26	1	0.09	1.79	1.000	0.704	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
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AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
<b>STEP = IEBCOPY</b>									
<b>JOBNAME</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>CPU</b>	<b>WAIT</b>	
COPY1	1	1.45	86.34	1	1.54	118.81	0.942	0.727	
COPY2	1	0.11	2.53	1	0.10	2.89	1.100	0.875	
<b>TOTAL</b>	<b>2</b>	<b>1.56</b>	<b>88.87</b>	<b>2</b>	<b>1.64</b>	<b>121.70</b>	<b>0.951</b>	<b>0.730</b>	
<b>MEAN</b>	<b>2</b>	<b>0.78</b>	<b>44.43</b>	<b>2</b>	<b>0.82</b>	<b>60.85</b>	<b>1.021</b>	<b>0.801</b>	
<b>STEP = IEBGENER</b>									
<b>JOBNAME</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>CPU</b>	<b>WAIT</b>	
GENER1	5	0.23	19.65	5	0.21	29.57	1.093	0.664	
GENER2	7	0.10	6.19	7	0.12	6.22	0.835	0.995	
<b>TOTAL</b>	<b>12</b>	<b>1.88</b>	<b>141.58</b>	<b>12</b>	<b>1.92</b>	<b>191.39</b>	<b>0.979</b>	<b>0.740</b>	
<b>MEAN</b>	<b>2</b>	<b>0.17</b>	<b>12.92</b>	<b>2</b>	<b>0.17</b>	<b>17.89</b>	<b>0.964</b>	<b>0.830</b>	
<b>STEP = IEBPTPCH</b>									
<b>JOBNAME</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>CPU</b>	<b>WAIT</b>	
PTPCH1	1	0.18	3.10	1	0.18	1.40	1.000	2.214	
PTPCH2	2	0.12	2.28	2	0.13	2.35	0.962	0.972	
<b>TOTAL</b>	<b>3</b>	<b>0.43</b>	<b>7.67</b>	<b>3</b>	<b>0.44</b>	<b>6.10</b>	<b>0.977</b>	<b>1.257</b>	
<b>MEAN</b>	<b>2</b>	<b>0.15</b>	<b>2.69</b>	<b>2</b>	<b>0.15</b>	<b>1.87</b>	<b>0.981</b>	<b>1.593</b>	
<b>STEP = IEBUPDAT</b>									
<b>JOBNAME</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>STEPS</b>	<b>CPU</b>	<b>WAIT</b>	<b>CPU</b>	<b>WAIT</b>	
UPDAT1	3	0.18	2.86	3	0.19	2.93	0.948	0.975	
UPDAT2	1	0.26	4.21	1	0.20	8.97	1.300	0.469	
<b>TOTAL</b>	<b>4</b>	<b>0.81</b>	<b>12.79</b>	<b>4</b>	<b>0.78</b>	<b>17.77</b>	<b>1.038</b>	<b>0.720</b>	
<b>MEAN</b>	<b>2</b>	<b>0.22</b>	<b>3.53</b>	<b>2</b>	<b>0.20</b>	<b>5.95</b>	<b>1.124</b>	<b>0.722</b>	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = IEBUPDTE

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
GENUPDATE	3	0.39	4.84	3	0.39	3.04	1.009	1.593
UPDTE1	1	0.13	2.84	1	0.12	3.04	1.083	0.934
UPDTE2	2	0.10	3.18	2	0.13	2.99	0.808	1.063
UPDTE3	1	0.04	0.46	1	0.05	0.22	0.800	2.091
UPDTE4	1	0.34	3.34	1	0.35	1.75	0.971	1.909
UPDTE5	1	0.10	5.26	1	0.12	2.44	0.833	2.156
UPDTE6	2	0.18	1.91	2	0.17	1.69	1.029	1.127
TOTAL	11	2.35	36.60	11	2.41	25.94	0.975	1.411
MEAN	7	0.18	3.12	7	0.19	2.17	0.933	1.553

STEP = IEHLIST

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
LIST1	3	0.22	5.86	3	0.23	4.20	0.971	1.395
LIST2	3	0.20	5.96	3	0.20	4.97	1.000	1.200
LIST3	2	0.52	20.91	2	0.54	18.39	0.954	1.137
LIST4	3	0.14	5.19	3	0.14	4.17	1.024	1.244
LIST5	2	0.31	24.94	2	0.35	17.10	0.873	1.458
TOTAL	13	3.36	142.75	13	3.51	111.02	0.957	1.286
MEAN	5	0.28	12.57	5	0.29	9.77	0.964	1.287

STEP = IEHMOVE

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
COMPMOVE	1	0.39	15.28	1	0.43	12.00	0.907	1.273
MOVE1	3	0.35	13.81	3	0.34	5.48	1.010	2.518
UTILITY1	1	0.29	13.57	1	0.38	7.00	0.763	1.939
TOTAL	5	1.72	70.27	5	1.84	35.45	0.935	1.982
MEAN	3	0.34	14.22	3	0.38	8.16	0.993	1.910

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

STEP = IEHPROGM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
GENUPDTE	3	0.06	0.96	3	0.07	0.94		0.818	1.018		
UTILITY1	4	0.06	1.56	4	0.07	1.03		0.833	1.510		
TOTAL	7	0.43	9.13	7	0.52	6.97		0.827	1.310		
MEAN	2	0.06	1.26	2	0.07	0.99		0.826	1.264		

STEP = LOAD&GO

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
BMKJSMP1	1	173.93	1.72	1	248.08	2.34		0.701	0.735		
BMKJS03B	2	1.91	2.03	2	1.59	1.73		1.201	1.173		
BMKJS06B	3	0.93	4.75	3	0.90	3.24		1.033	1.465		
BMKJS07B	3	0.17	2.20	3	0.18	3.20		0.943	0.689		
BMKJS08A	2	0.44	2.89	2	0.55	3.10		0.800	0.934		
BMKJS08B	2	0.47	2.93	2	0.55	3.66		0.855	0.802		
BMKJS09B	2	4.63	231.69	2	4.90	193.81		0.946	1.195		
BMKJS10B	4	0.13	2.57	4	0.14	3.18		0.911	0.810		
BMKJS11B	3	2.62	1.60	3	2.45	3.48		1.069	0.460		
BMKJS13B	2	0.54	1.84	2	0.64	3.11		0.837	0.593		
BMKJS22A	2	7.76	20.67	2	9.69	47.70		0.800	0.433		
BMKJS23A	2	0.09	1.56	2	0.11	1.55		0.864	1.006		
BMKJS23B	3	0.08	2.70	3	0.11	1.75		0.727	1.544		
BMKJS24A	2	61.29	76.55	2	72.87	74.73		0.841	1.024		
BMKJS24B	2	1.60	4.52	2	1.85	5.88		0.865	0.770		
DMATMUL	1	251.26	2.69	1	92.84	2.73		2.706	0.985		
EMATMUL	1	143.89	1.90	1	89.73	3.17		1.604	0.599		
NATRAN	1	88.22	2.73	1	78.84	3.46		1.119	0.789		
TOTAL	38	826.70	742.50	38	706.49	729.97		1.170	1.017		
MEAN	18	41.11	20.42	18	33.67	20.10		1.046	0.889		

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AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

STEP = PL1

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
BMKJS01A	4	0.90	6.74	4	1.10	7.07	0.820	0.953	
BMKJS02A	3	1.40	6.75	3	1.78	6.37	0.788	1.059	
BMKJS22A	1	9.93	15.62	1	13.10	25.03	0.758	0.624	
TOTAL	8	17.73	62.81	8	22.82	72.41	0.777	0.867	
MEAN	3	4.08	9.70	3	5.32	12.82	0.789	0.879	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = IEBUTIL

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
COMPMOVE	1	0.09	1.26	1	0.09	1.79		1.000	0.704		
COPY1	1	1.45	86.34	1	1.54	118.81		0.942	0.727		
COPY2	1	0.11	2.53	1	0.10	2.89		1.100	0.875		
GENER1	5	0.23	19.65	5	0.21	29.57		1.093	0.664		
GENER2	7	0.10	6.19	7	0.12	6.22		0.835	0.995		
GENUPDTE	3	0.39	4.84	3	0.39	3.04		1.009	1.593		
PTPCH1	1	0.18	3.10	1	0.18	1.40		1.000	2.214		
PTPCH2	2	0.12	2.28	2	0.13	2.35		0.962	0.972		
UPDAT1	3	0.18	2.86	3	0.19	2.93		0.948	0.975		
UPDAT2	1	0.26	4.21	1	0.20	8.97		1.300	0.469		
UPDTE1	1	0.13	2.84	1	0.12	3.04		1.083	0.934		
UPDTE2	2	0.10	3.18	2	0.13	2.99		0.808	1.063		
UPDTE3	1	0.04	0.46	1	0.05	0.22		0.800	2.091		
UPDTE4	1	0.34	3.34	1	0.35	1.75		0.971	1.909		
UPDTE5	1	0.10	5.26	1	0.12	2.44		0.833	2.156		
UPDTE6	2	0.18	1.91	2	0.17	1.69		1.029	1.127		
TOTAL	33	7.12	288.77	33	7.28	364.69		0.978	0.792		
MEAN	16	0.25	9.39	16	0.26	11.88		0.982	1.217		

STEP = IEHUTIL

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
COMPMOVE	1	0.39	15.28	1	0.43	12.00		0.907	1.273		
GENUPDTE	3	0.06	0.96	3	0.07	0.94		0.818	1.018		
LIST1	3	0.22	5.86	3	0.23	4.20		0.971	1.395		
LIST2	3	0.20	5.96	3	0.20	4.97		1.000	1.200		
LIST3	2	0.52	20.91	2	0.54	18.39		0.954	1.137		
LIST4	3	0.14	5.19	3	0.14	4.17		1.024	1.244		
LIST5	2	0.31	24.94	2	0.35	17.10		0.873	1.458		
MOVE1	3	0.35	13.81	3	0.34	5.48		1.010	2.518		
UTILITY1	5	0.11	3.96	5	0.14	2.23		0.794	1.779		
TOTAL	25	5.51	222.15	25	5.87	153.44		0.939	1.448		
MEAN	9	0.26	10.76	9	0.27	7.72		0.928	1.447		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = UTILITY									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT
COMPMOVE	2	0.24	8.27	2	0.26	6.89		0.923	1.199
COPY1	1	1.45	86.34	1	1.54	118.81		0.942	0.727
COPY2	1	0.11	2.53	1	0.10	2.89		1.100	0.875
GENER1	5	0.23	19.65	5	0.21	29.57		1.093	0.664
GENER2	7	0.10	6.19	7	0.12	6.22		0.835	0.995
GENUPDTE	6	0.23	2.90	6	0.23	1.99		0.978	1.456
LIST1	3	0.22	5.86	3	0.23	4.20		0.971	1.395
LIST2	3	0.20	5.96	3	0.20	4.97		1.000	1.200
LIST3	2	0.52	20.91	2	0.54	18.39		0.954	1.137
LIST4	3	0.14	5.19	3	0.14	4.17		1.024	1.244
LIST5	2	0.31	24.94	2	0.35	17.10		0.873	1.458
MOVE1	3	0.35	13.81	3	0.34	5.48		1.010	2.518
PTPCH1	1	0.18	3.10	1	0.18	1.40		1.000	2.214
PTPCH2	2	0.12	2.28	2	0.13	2.35		0.962	0.972
UPDAT1	3	0.18	2.86	3	0.19	2.93		0.948	0.975
UPDAT2	1	0.26	4.21	1	0.20	8.97		1.300	0.469
UPDTE1	1	0.13	2.84	1	0.12	3.04		1.083	0.934
UPDTE2	2	0.10	3.18	2	0.13	2.99		0.808	1.063
UPDTE3	1	0.04	0.46	1	0.05	0.22		0.800	2.091
UPDTE4	1	0.34	3.34	1	0.35	1.75		0.971	1.909
UPDTE5	1	0.10	5.26	1	0.12	2.44		0.833	2.156
UPDTE6	2	0.18	1.91	2	0.17	1.69		1.029	1.127
UTILITY1	5	0.11	3.96	5	0.14	2.23		0.794	1.779
TOTAL	58	12.63	510.92	58	13.15	518.13		0.960	0.986
MEAN	23	0.25	10.26	23	0.26	10.90		0.967	1.329

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 MODIFIED MODEL JOBSTREAM

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TOTALS

STEPNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ASM	52	0.27	4.15	52	0.29	4.74	0.920	0.875
EDT	45	0.30	9.40	45	0.37	8.91	0.808	1.055
FTG	17	1.49	1.92	17	1.90	1.81	0.782	1.057
FTH	35	3.85	12.01	35	4.61	9.41	0.834	1.277
GO	109	12.21	5.77	109	9.43	6.35	1.295	0.908
IEBCOMPR	1	0.09	1.26	1	0.09	1.79	1.000	0.704
IEBCOPY	2	0.78	44.43	2	0.82	60.85	0.951	0.730
IEBGENER	12	0.16	11.80	12	0.16	15.95	0.979	0.740
IEBPTPCH	3	0.14	2.56	3	0.15	2.03	0.977	1.257
IEBUPDAT	4	0.20	3.20	4	0.19	4.44	1.038	0.720
IEBUPDTE	11	0.21	3.33	11	0.22	2.36	0.975	1.411
IEHLIST	13	0.26	10.98	13	0.27	8.54	0.957	1.286
IEHMOVE	5	0.34	14.05	5	0.37	7.09	0.935	1.982
IEHPROGM	7	0.06	1.30	7	0.07	1.00	0.827	1.310
LOAD&GO	38	21.76	19.54	38	18.59	19.21	1.170	1.017
PL1	8	2.22	7.85	8	2.85	9.05	0.777	0.867
TOTAL	362	2375.43	3036.86	362	1995.79	3020.54	1.190	1.005
MEAN	16	2.77	9.60	16	2.52	10.22	0.952	1.075

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MODIFIED MODEL JOBSTREAM

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

## SUMMARY OF STEP MEANS

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
ASM	5	0.47	7.53	5	0.52	8.51	0.909	0.876
EDT	21	0.30	9.49	21	0.37	8.77	0.836	1.110
FTG	10	2.16	1.82	10	2.76	1.74	0.779	1.173
FTH	27	3.89	11.23	27	4.67	8.81	0.839	1.392
GO	21	12.18	9.01	21	9.09	10.11	1.422	1.066
IEBCOMPR	1	0.09	1.26	1	0.09	1.79	1.000	0.704
IEBCOPY	2	0.78	44.43	2	0.82	60.85	1.021	0.801
IEBGENER	2	0.17	12.92	2	0.17	17.89	0.964	0.830
IEBPTPCH	2	0.15	2.69	2	0.15	1.87	0.981	1.593
IEBUPDAT	2	0.22	3.53	2	0.20	5.95	1.124	0.722
IEBUPDTE	7	0.18	3.12	7	0.19	2.17	0.933	1.553
IEHLIST	5	0.28	12.57	5	0.29	9.77	0.964	1.287
IEHMOVE	3	0.34	14.22	3	0.38	8.16	0.893	1.910
IEHPROGM	2	0.06	1.26	2	0.07	0.99	0.826	1.264
LOAD&GO	18	41.11	20.42	18	33.67	20.10	1.046	0.989
PL1	3	4.08	9.70	3	5.32	12.82	0.789	0.879
TOTAL	131	1149.96	1402.51	131	983.68	1360.04	1.169	1.031
MEAN	16	4.15	10.33	16	3.67	11.27	0.958	1.128

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT	CPU	WAIT
ANLTRIM	1	138.71	34.80	1	113.74	34.83	1.220	0.999
DOT2	1	349.07	90.54	1	408.06	85.52	0.855	1.059
DROPLET	1	489.70	5.06	1	283.43	5.21	1.728	0.971
EIGEN	1	23.76	9.28	1	15.38	8.55	1.545	1.085
EROS	1	154.55	145.78	1	171.95	145.33	0.899	1.003
HEPCVT	1	78.99	54.11	1	99.41	84.12	0.795	0.643
KTTFLCK	1	70.43	23.70	1	72.72	16.19	0.969	1.464
LIFE1A	1	170.15	40.45	1	153.32	85.46	1.110	0.473
LINDA	1	266.36	207.74	1	328.30	148.19	0.811	1.402
MATRIX	3	75.06	22.68	3	45.11	13.61	1.664	1.666
MONTE	1	210.30	16.17	1	169.67	7.71	1.239	2.097
MULTC	1	100.59	60.74	1	81.16	34.55	1.239	1.758
NVERTEX	3	100.97	75.01	3	112.83	73.05	0.895	1.027
OWL	1	116.93	47.88	1	127.70	22.50	0.916	2.128
REXCO	1	196.46	19.18	1	156.20	16.92	1.258	1.134
SDIAG	1	35.17	23.16	1	15.63	4.62	2.250	5.013
SUMX	1	30.01	212.09*	1	109.03	184.55		
TOTAL	16	2577.20	876.28	16	2354.61	786.37	1.095	1.114
MEAN	16	161.08	54.77	16	147.16	49.15	1.212	1.495

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
STEP = FTH									
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT	
ANLTRIM	1	13.35	25.58	1	17.77	22.56	0.751	1.134	
DOT2	1	26.71	48.65	1	35.11	34.44	0.761	1.413	
DROPLET	1	1.70	3.12	1	2.14	2.15	0.794	1.451	
EIGEN	1	2.28	6.41	1	3.05	4.68	0.748	1.370	
EROS	1	19.51	58.71	1	25.92	49.86	0.753	1.177	
KTTLFLCK	1	3.14	22.22	1	4.19	14.59	0.749	1.523	
LIFE1A	1	20.73	33.24	1	27.26	75.46	0.760	0.440	
LINDA	1	40.38	105.24	1	51.95	57.12	0.777	1.842	
MATRIX	3	7.04	19.64	3	8.84	11.69	0.796	1.680	
MONTE	1	6.01	14.35	1	7.25	5.49	0.829	2.614	
MULTC	1	10.36	58.18	1	12.47	15.86	0.831	3.668	
NVERTEX	3	15.39	71.61	3	19.95	51.78	0.772	1.393	
OWL	1	3.18	44.83	1	4.06	17.51	0.783	2.560	
REXCO	1	18.21	16.10	1	22.38	13.16	0.814	1.223	
SDIAG	1	1.87	16.75	1	2.31	3.18	0.810	5.267	
SUMX	1	28.95	204.10	1	35.81	148.22	0.808	1.377	
TOTAL	16	218.81	748.73	16	280.46	527.75	0.780	1.419	
MEAN	16	13.68	46.80	16	17.53	32.98	0.784	1.883	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS

AMDAHL 470V/6				IBM 370/195				AMDAHL / TBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
EROS	1	0.41	3.93	1	0.52	5.70		0.788	0.689		
SUMX	1	0.62	3.60	1	0.65	4.53		0.954	0.795		
TOTAL	2	1.03	7.53	2	1.17	10.23		0.880	0.736		
MEAN	2	0.51	3.76	2	0.58	5.11		0.871	0.742		

AMDAHL 470V/6				IBM 370/195				AMDAHL / TBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
LINDA	1	225.98	102.50	1	276.35	91.07		0.818	1.126		
SUMX	1	0.44	4.39*	1	72.57	31.80					
TOTAL	1	225.98	102.50	1	276.35	91.07		0.818	1.126		
MEAN	1	225.98	102.50	1	276.35	91.07		0.818	1.126		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = LOAD&amp;GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
ANLTRIM	1	125.36	9.22	1	95.97	12.27	1.306	0.751
DOT2	1	322.36	41.89	1	372.95	51.08	0.964	0.820
DROPLET	1	488.00	1.94	1	281.29	3.06	1.735	0.634
EIGEN	1	21.48	2.87	1	12.33	3.87	1.742	0.742
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926
HEPCVT	1	61.64	10.64	1	74.68	12.21	0.825	0.871
KTTLFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925
LIFE1A	1	149.42	7.21	1	126.06	10.00	1.185	0.721
MATRIX	3	68.02	3.04	3	36.27	1.92	1.875	1.583
MONTE	1	204.29	1.82	1	162.42	2.22	1.258	0.820
MULTC	1	90.23	2.56	1	68.69	18.69	1.314	0.137
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611
REXCO	1	178.25	3.08	1	133.82	3.76	1.332	0.819
SDIAG	1	33.30	6.41	1	13.32	1.44	2.500	4.451
TOTAL	15	2143.60	181.75	15	1808.36	238.16	1.185	0.763
MEAN	15	142.91	12.12	15	120.56	15.88	1.312	0.998

STEP = PL1

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
HEPCVT	1	17.35	43.47	1	24.73	71.91	0.702	0.605
TOTAL	1	17.35	43.47	1	24.73	71.91	0.702	0.605
MEAN	1	17.35	43.47	1	24.73	71.91	0.702	0.605

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / TBM

## SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
ASM	2	0.51	3.76	2	0.58	5.11	0.880	0.736
EDT&GO	1	225.98	102.50	1	276.35	91.07	0.818	1.126
FTH	16	13.68	46.80	16	17.53	32.98	0.780	1.419
LOAD&GO	15	142.91	12.12	15	120.56	15.88	1.185	0.763
PL1	1	17.35	43.47	1	24.73	71.91	0.702	0.605

## SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
ASM	2	0.51	3.76	2	0.58	5.11	0.871	0.742
EDT&GO	1	225.98	102.50	1	276.35	91.07	0.818	1.126
FTH	16	13.68	46.80	16	17.53	32.98	0.784	1.883
LOAD&GO	15	142.91	12.12	15	120.56	15.88	1.312	0.998
PL1	1	17.35	43.47	1	24.73	71.91	0.702	0.605

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
SINGLE PRECISION APPLICATIONS PROBLEMS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
DOT2	1	349.07	90.54	1	408.06	85.52	0.855	1.059
EROS	1	154.55	145.78	1	171.95	145.33	0.899	1.003
KTTLFLCK	1	70.43	23.70	1	72.72	16.19	0.969	1.464
LINDA	1	266.36	207.74	1	328.30	148.19	0.811	1.402
NVERTEX	3	100.97	75.01	3	112.83	73.05	0.895	1.027
OWL	1	116.93	47.88	1	127.70	22.50	0.916	2.128
TOTAL	6	1058.31	590.65	6	1221.56	490.78	0.866	1.203
MEAN	6	176.39	98.44	6	203.59	81.80	0.891	1.347

STEP = EDT&amp;GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
LINDA	1	225.98	102.50	1	276.35	91.07	0.818	1.126
TOTAL	1	225.98	102.50	1	276.35	91.07	0.818	1.126
MEAN	1	225.98	102.50	1	276.35	91.07	0.818	1.126

STEP = LOAD&amp;GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
DOT2	1	322.36	41.89	1	372.95	51.08	0.864	0.820
EROS	1	134.63	83.14	1	145.51	89.77	0.925	0.926
KTTLFLCK	1	67.29	1.48	1	68.53	1.60	0.982	0.925
NVERTEX	3	85.58	3.40	3	92.88	21.28	0.921	0.160
OWL	1	113.75	3.05	1	123.64	4.99	0.920	0.611
TOTAL	5	723.61	132.96	5	803.51	168.72	0.901	0.788
MEAN	5	144.72	26.59	5	160.70	33.74	0.923	0.688

**ARGONNE NATIONAL LABORATORY**  
**AMDAHL 470V/6 VS. IBM 370/195**  
**DOUBLE PRECISION APPLICATIONS PROBLEMS**

**AMDAHL 470V/6**      **IBM 370/195**      **AMDAHL / IBM**

IBM 370/195

AMDAHL / IBM

JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
ANLTRIM	1	138.71	34.80	1	113.74	34.83	1.220	0.999
DROPLET	1	489.70	5.06	1	283.43	5.21	1.728	0.971
EIGEN	1	23.76	9.28	1	15.38	8.55	1.545	1.085
LIFE1A	1	170.15	40.45	1	153.32	85.46	1.110	0.473
MATRIX	3	75.06	22.68	3	45.11	13.61	1.664	1.666
MONTE	1	210.30	16.17	1	169.67	7.71	1.239	2.097
MULTC	1	100.59	60.74	1	81.16	34.55	1.239	1.758
REXCO	1	196.46	19.18	1	156.20	16.92	1.258	1.134
SDIAG	1	35.17	23.16	1	15.63	4.62	2.250	5.013
SUMX	1	30.01	212.09*	1	109.03	184.55		
TOTAL	9	1439.90	231.52	9	1033.64	211.46	1.393	1.095
MEAN	9	159.99	25.72	9	114.85	23.50	1.473	1.689

**AMDAHL 470V/6**      **IBM 370/195**      **AMDAHL / IBM**

IBM 370/195

AMDAHL / IBM

STEP = LOAD&GO

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
USER JOBS AND TUNED KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

JOBNAME	JOB	CPU	WAIT	JOB	CPU	WAIT	CPU	WAIT
BIGREBUS	1	506.52	382.78	1	279.36	335.52	1.813	1.141
BISONINT	1	649.65	593.18	1	379.54	329.20	1.712	1.802
BITSFT	1	28.63	0.15	1	39.27	0.18	0.729	0.833
DIF1DADJ	1	130.59	17.03	1	73.94	16.96	1.766	1.004
DIF1DMOD	1	512.97	36.72	1	292.34	54.68	1.755	0.672
DIF1DRL	1	35.51	17.51	1	21.70	16.37	1.636	1.070
DMATMUL	1	244.10	10.52	1	89.49	9.58	2.728	1.098
EMATMUL	1	140.50	9.83	1	90.03	12.79	1.561	0.769
FORTLIBD	1	117.13	8.28	1	78.72	6.38	1.488	1.298
FORTLIBE	1	72.03	8.87	1	83.42	9.31	0.863	0.953
FSQRT	1	297.06	5.70	1	83.30	6.08	3.566	0.937
FX2DEMO	1	453.98	281.06	1	321.12	290.55	1.414	0.967
MINVERT	1	81.49	6.17	1	70.86	4.74	1.150	1.302
MORETEST	2	33.39	0.25	2	40.56	0.44	0.823	0.562
NATRAN	1	95.08	16.21	1	87.58	18.29	1.086	0.886
OVCBENCH	1	621.05	133.81	1	278.66	104.60	2.229	1.279
REBUSTST	1	113.64	151.79	1	77.86	159.68	1.460	0.951
SASBENCH	1	193.59	4.33	1	171.03	7.05	1.132	0.614
TOTAL	18	4326.91	1684.19	18	2558.78	1382.40	1.691	1.218
MEAN	18	240.38	93.57	18	142.15	76.80	1.606	1.008

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 USER JOBS AND TUNED KERNELS

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

STEP = FTH

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
DMATMUL	1	1.27	9.09	1	1.53	8.11	0.830	1.121
EMATMUL	1	1.26	8.37	1	1.56	11.36	0.808	0.737
FORTLIBD	1	0.56	5.70	1	0.67	2.63	0.836	2.167
FORTLIBE	1	0.52	6.21	1	0.67	2.66	0.776	2.335
FSQRT	1	0.45	4.35	1	0.64	4.00	0.703	1.087
MINVERT	1	0.86	4.79	1	1.04	3.42	0.827	1.401
NATRAN	1	6.10	14.10	1	7.89	13.87	0.773	1.017
TOTAL	7	11.02	52.61	7	14.00	46.05	0.787	1.142
MEAN	7	1.57	7.52	7	2.00	6.58	0.793	1.409

STEP = GO

JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT	CPU	WAIT
BIGREBUS	1	506.52	382.78	1	279.36	335.52	1.813	1.141
BISONINT	1	649.65	593.18	1	379.54	329.20	1.712	1.802
BITSET	1	28.63	0.15	1	39.27	0.18	0.729	0.833
DIF1DADJ	1	130.59	17.03	1	73.94	16.96	1.766	1.004
DIF1DMOD	1	512.97	36.72	1	292.34	54.68	1.755	0.672
DIF1DRL	1	35.51	17.51	1	21.70	16.37	1.636	1.070
FX2DEMO	1	453.98	281.06	1	321.12	290.55	1.414	0.967
MORETEST	2	33.39	0.25	2	40.56	0.44	0.823	0.562
OVCBENCH	1	621.05	133.81	1	278.66	104.60	2.229	1.279
REBUSTST	1	113.64	151.79	1	77.86	159.68	1.460	0.951
SASBENCH	1	193.59	4.33	1	171.03	7.05	1.132	0.614
TOTAL	11	3279.52	1618.61	11	1975.38	1315.23	1.660	1.231
MEAN	11	298.14	147.15	11	179.58	119.57	1.497	0.990

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
USER JOBS AND TUNED KERNELS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
STEP = LOADGO											
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
DMATMUL	1	242.83	1.43	1	87.96	1.47		2.761	0.973		
EMATMUL	1	139.24	1.46	1	88.47	1.43		1.574	1.021		
FORTLIBD	1	116.57	2.58	1	78.05	3.75		1.494	0.688		
FORTLIBE	1	71.51	2.66	1	82.75	6.65		0.864	0.400		
FSQRT	1	296.61	1.35	1	82.66	2.08		3.588	0.649		
MINVERT	1	80.63	1.38	1	69.82	1.32		1.155	1.045		
NATRAN	1	88.98	2.11	1	79.69	4.42		1.117	0.477		
TOTAL	7	1036.37	12.97	7	569.40	21.12		1.820	0.614		
MEAN	7	148.05	1.85	7	81.34	3.02		1.793	0.751		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
USER JOBS AND TUNED KERNELS

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AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
FTH	7	1.57	7.52	7	2.00	6.58	0.787	1.142
GO	11	298.14	147.15	11	179.58	119.57	1.660	1.231
LOADGO	7	148.05	1.85	7	81.34	3.02	1.820	0.614

SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
FTH	7	1.57	7.52	7	2.00	6.58	0.793	1.409
GO	11	298.14	147.15	11	179.58	119.57	1.497	0.990
LOADGO	7	148.05	1.85	7	81.34	3.02	1.793	0.751

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
SELECTED FORTRAN LIBRARY ROUTINES

AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

FUNCTION	JOBs	REAL4	REAL8	JOBs	REAL4	REAL8	REAL4	REAL8
FXP	1	12.60	14.12	1	12.06	10.32	1.044	1.369
LOG	1	8.16	17.64	1	7.13	8.70	1.145	2.027
SIN	1	8.24	20.31	1	8.75	10.53	0.941	1.929
SQRT	1	7.39	12.39	1	6.66	7.32	1.110	1.693
X ** Y	1	24.35	39.74	1	32.84	26.28	0.742	1.512
TOTAL	5	60.74	104.20	5	67.45	63.15	0.901	1.650
MEAN	5	12.15	20.84	5	13.49	12.63	0.996	1.706

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

DIMENSION	JOBs	REAL4	REAL8	JOBs	REAL4	REAL8	REAL4	REAL8
38X38	1	113.41	191.62	1	74.11	71.14	1.530	2.694
39X39	1	125.57	208.00	1	83.16	77.34	1.510	2.689
40X40	1	135.42	225.02	1	87.24	82.01	1.552	2.744
57X57	1	393.22	744.58	1	259.94	238.58	1.513	3.121
58X58	1	403.71	747.14	1	260.98	249.09	1.547	2.999
59X59	1	432.26	783.49	1	290.34	263.26	1.489	2.976
60X60	1	445.06	813.18	1	291.04	274.51	1.529	2.962
78X78	1	1047.94	1757.82	1	634.26	663.74	1.652	2.648
79X79	1	1099.26	1891.58	1	687.62	705.67	1.599	2.681
80X80	1	1112.20	1906.05	1	689.33	721.04	1.613	2.643
TOTAL	10	5308.04	9268.47	10	3358.02	3346.39	1.581	2.770
MEAN	10	530.80	926.85	10	335.80	334.64	1.553	2.816

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

KERNEL = CRITH										
DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8		
38X38	1	30.34	49.92	1	24.84	24.81	1.221	2.012		
39X39	1	33.54	54.53	1	26.77	26.86	1.253	2.030		
40X40	1	36.48	58.75	1	29.33	28.89	1.244	2.034		
57X57	1	106.88	187.26	1	84.58	83.22	1.264	2.250		
58X58	1	108.29	193.54	1	88.23	87.14	1.227	2.221		
59X59	1	115.58	201.34	1	94.12	91.61	1.228	2.199		
60X60	1	120.19	212.22	1	98.91	96.09	1.215	2.209		
78X78	1	277.50	455.17	1	214.26	220.72	1.295	2.062		
79X79	1	289.02	480.00	1	223.53	228.43	1.293	2.101		
80X80	1	296.45	496.00	1	233.44	237.41	1.270	2.089		
TOTAL	10	1414.27	2388.73	10	1118.02	1125.18	1.265	2.123		
MEAN	10	141.43	238.87	10	111.80	112.52	1.251	2.121		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8		REAL4	REAL8
*****									
38X38	1	17.28	31.49	1	9.82	7.57	1.760	4.161	
39X39	1	18.94	34.18	1	10.76	8.44	1.761	4.047	
40X40	1	20.10	36.61	1	11.24	8.14	1.789	4.500	
57X57	1	57.47	122.62	1	32.46	24.00	1.770	5.109	
58X58	1	59.65	121.98	1	34.02	25.79	1.753	4.730	
59X59	1	64.38	129.28	1	37.48	28.17	1.718	4.589	
60X60	1	64.51	134.91	1	37.00	27.50	1.744	4.906	
78X78	1	160.13	291.97	1	82.84	79.08	1.933	3.692	
79X79	1	170.37	323.46	1	87.26	95.41	1.953	3.390	
80X80	1	164.48	310.66	1	88.47	79.72	1.859	3.897	
TOTAL	10	797.31	1537.15	10	431.34	383.82	1.848	4.005	
MEAN	10	79.73	153.72	10	43.13	38.38	1.804	4.302	

KERNEL = ERITH

DIMENSION	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8
*****								
38X38	1	21.38	36.35	1	11.56	11.37	1.848	3.198
39X39	1	23.94	39.30	1	15.25	12.20	1.569	3.220
40X40	1	25.73	42.24	1	13.72	13.19	1.875	3.202
57X57	1	74.62	144.26	1	48.25	39.16	1.547	3.683
58X58	1	77.44	142.08	1	40.74	40.24	1.901	3.531
59X59	1	83.46	148.22	1	53.75	42.17	1.553	3.515
60X60	1	85.76	153.98	1	45.70	44.47	1.876	3.462
78X78	1	200.70	336.00	1	99.20	109.28	2.023	3.075
79X79	1	209.79	364.80	1	128.01	116.06	1.639	3.143
80X80	1	215.30	363.01	1	108.20	119.69	1.990	3.033
TOTAL	10	1018.11	1770.24	10	564.40	547.84	1.804	3.231
MEAN	10	101.81	177.02	10	56.44	54.78	1.782	3.306

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
KERNEL = FRITH								REAL4	REAL8
*	-----*	-----*	-----*	*	-----*	-----*	-----*	*	-----*
	DIMENSION	STEPS	REAL4	REAL8		STEPS	REAL4	REAL8	
*	-----*	-----*	-----*	-----*	*	-----*	-----*	-----*	-----*
	38X38	1	18.94	33.15		1	10.80	10.36	
	39X39	1	21.25	36.22		1	11.94	11.44	
	40X40	1	22.40	39.17		1	12.69	12.01	
	57X57	1	65.41	133.25		1	36.18	35.09	
	58X58	1	66.82	130.18		1	37.29	36.16	
	59X59	1	71.81	137.60		1	40.24	38.47	
	60X60	1	73.86	139.14		1	41.58	40.24	
	78X78	1	174.34	300.42		1	89.46	99.23	
	79X79	1	185.22	326.91		1	94.44	104.44	
	80X80	1	185.86	326.91		1	96.86	109.96	
*	-----*	-----*	-----*	-----*	*	-----*	-----*	-----*	-----*
	TOTAL	10	885.90	1602.94		10	471.48	497.40	
	MEAN	10	88.59	160.29		10	47.15	49.74	
*	-----*	-----*	-----*	-----*	*	-----*	-----*	-----*	-----*

ARGONNE NATIONAL LABORATORY  
 AMDAHL 470V/6 VS. IBM 370/195  
 MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6                    IBM 370/195                    AMDAHL / IBM

KERNEL	JOBS	REAL4	REAL8	JOBS	REAL4	REAL8	REAL4	REAL8
BRITH	1	1192.45	1969.41	1	772.77	792.15	1.543	2.486
CRITH	1	1414.27	2388.73	1	1118.02	1125.18	1.265	2.123
DRITH	1	797.31	1537.15	1	431.34	383.82	1.848	4.005
ERITH	1	1018.11	1770.24	1	564.40	547.84	1.804	3.231
FRITH	1	885.90	1602.94	1	471.48	497.40	1.879	3.223
TOTAL	5	5308.04	9268.47	5	3358.02	3346.39	1.581	2.770
MEAN	5	1061.61	1853.69	5	671.60	669.28	1.668	3.014

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

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AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
DIMENSION = 57X57									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8		REAL4	REAL8
BRITH	1	88.83	157.18	1	58.47	57.10		1.519	2.753
CRITH	1	106.88	187.26	1	84.58	83.22		1.264	2.250
DRITH	1	57.47	122.62	1	32.46	24.00		1.770	5.109
ERITH	1	74.62	144.26	1	48.25	39.16		1.547	3.683
FRITH	1	65.41	133.25	1	36.18	35.09		1.808	3.797
TOTAL	5	393.22	744.58	5	259.94	238.58		1.513	3.121
MEAN	5	78.64	148.92	5	51.99	47.72		1.582	3.519

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DIMENSION = 59X59
*-----*-----*-----*-----*
|   KERNEL    | STEPS   REAL4    REAL8   | STEPS   REAL4    REAL8   |   REAL4    REAL8   |
|             |          |          |          |          |          |          |          |          |
*-----*-----*-----*-----*-----*
| BRITH      | 1       97.02   167.04 | 1       64.75   62.84 | 1.498   2.658 |
| CRITH      | 1      115.58   201.34 | 1      94.12   91.61 | 1.228   2.198 |
| DRITH      | 1       64.38   129.28 | 1      37.48   28.17 | 1.718   4.589 |
| ERITH      | 1       83.46   148.22 | 1      53.75   42.17 | 1.553   3.515 |
| FRITH      | 1      71.81   137.60 | 1      40.24   38.47 | 1.784   3.577 |
*-----*-----*-----*-----*
| TOTAL      | 5      432.26   783.49 | 5      290.34   263.26 | 1.489   2.976 |
| MEAN       | 5      86.45   156.70 | 5      58.07   52.65 | 1.556   3.307 |
*-----*-----*-----*-----*

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ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
MATRIX MULTIPLY KERNELS

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
DIMENSION = 60X60									
KERNEL	STEPS	REAL4	REAL8		STEPS	REAL4	REAL8	REAL4	REAL8
BRITH	1	100.74	172.93		1	67.84	66.21	1.485	2.612
CRITH	1	120.19	212.22		1	98.91	96.09	1.215	2.209
DRITH	1	64.51	134.91		1	37.00	27.50	1.744	4.906
ERITH	1	85.76	153.98		1	45.70	44.47	1.876	3.462
FRITH	1	73.86	139.14		1	41.58	40.24	1.776	3.458
TOTAL	5	445.06	813.18		5	291.04	274.51	1.529	2.962
MEAN	5	89.01	162.64		5	58.21	54.90	1.619	3.329
DIMENSION = 78X78									
KERNEL	STEPS	REAL4	REAL8		STEPS	REAL4	REAL8	REAL4	REAL8
BRITH	1	235.26	374.27		1	148.50	155.43	1.584	2.408
CRITH	1	277.50	455.17		1	214.26	220.72	1.295	2.062
DRITH	1	160.13	291.97		1	82.84	79.08	1.933	3.692
ERITH	1	200.70	336.00		1	99.20	109.28	2.023	3.075
FRITH	1	174.34	300.42		1	89.46	99.23	1.949	3.027
TOTAL	5	1047.94	1757.82		5	634.26	663.74	1.652	2.648
MEAN	5	209.59	351.56		5	126.85	132.75	1.757	2.353
DIMENSION = 79X79									
KERNEL	STEPS	REAL4	REAL8		STEPS	REAL4	REAL8	REAL4	REAL8
BRITH	1	244.86	396.42		1	154.38	161.33	1.586	2.457
CRITH	1	289.02	480.00		1	223.53	228.43	1.293	2.101
DRITH	1	170.37	323.46		1	87.26	95.41	1.953	3.390
FRITH	1	209.79	364.80		1	128.01	116.06	1.639	3.143
FRITH	1	185.22	326.91		1	94.44	104.44	1.961	3.130
TOTAL	5	1099.26	1891.58		5	687.62	705.67	1.599	2.681
MEAN	5	219.85	378.32		5	137.52	141.13	1.686	2.344

**ARGONNE NATIONAL LABORATORY**  
**AMDAHL 470V/6 VS. IBM 370/195**  
**MATRIX MULTIPLY KERNELS**

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AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM	
DIMENSION = 80X80									
KERNEL	STEPS	REAL4	REAL8	STEPS	REAL4	REAL8	REAL4	REAL8	
BRITH	1	250.11	409.47	1	162.35	174.27	1.541	2.350	
CRITH	1	296.45	496.00	1	233.44	237.41	1.270	2.089	
DRITH	1	164.48	310.66	1	88.47	79.72	1.859	3.897	
ERITH	1	215.30	363.01	1	108.20	119.69	1.990	3.033	
FRITH	1	185.86	326.91	1	96.86	109.96	1.919	2.973	
TOTAL	5	1112.20	1906.05	5	689.33	721.04	1.613	2.643	
MEAN	5	222.44	381.21	5	137.87	144.21	1.716	2.868	

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
NRL BENCHMARK KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	JOBS	CPU	WAIT	JOBS	CPU	WAIT		CPU	WAIT		
NRLICH01	1	163.54	21.77	1	157.47	6.98		1.039	3.119		
NRLICH02	1	129.98	15.13	1	111.97	4.49		1.161	3.370		
NRLICH04	1	127.92	20.89	1	110.59	8.69		1.157	2.404		
NRLICH05	1	150.43	7.07	1	136.43	7.82		1.103	0.904		
NRLICH06	1	154.67	5.94	1	124.94	5.25		1.238	1.131		
NRLICH07	1	221.75	4.14	1	94.29	3.66		2.352	1.131		
TOTAL	6	948.29	74.94	6	735.69	36.89		1.289	2.031		
MEAN	6	158.05	12.49	6	122.61	6.15		1.341	2.010		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
NRL BENCHMARK KERNELS

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AMDAHL 470V/6				IBM 370/195				AMDAHL / IBM			
JOBNAME	STEPS	CPU	WAIT	STEPS	CPU	WAIT		CPU	WAIT		
NRLICH01	1	0.13	5.52	1	0.17	3.04		0.765	1.816		
NRLICH02	1	0.12	5.76	1	0.15	2.02		0.800	2.851		
NRLICH04	1	0.12	4.49	1	0.15	4.69		0.800	0.957		
NRLICH05	1	0.16	2.92	1	0.16	3.68		1.000	0.793		
NRLICH06	1	0.13	2.72	1	0.16	2.74		0.813	0.993		
NRLICH07	1	0.16	2.21	1	0.16	2.14		1.000	1.033		
TOTAL	6	0.82	23.62	6	0.95	18.31		0.863	1.290		
MEAN	6	0.14	3.94	6	0.16	3.05		0.863	1.407		
STEP = FTH											
NRLICH01	1	1.03	15.99	1	1.25	3.36		0.824	4.759		
NRLICH02	1	0.68	8.96	1	0.84	2.29		0.810	3.913		
NRLICH04	1	0.70	16.12	1	0.83	3.70		0.843	4.357		
NRLICH05	1	1.01	3.92	1	1.33	3.94		0.759	0.995		
NRLICH06	1	0.96	3.01	1	1.16	2.29		0.828	1.314		
NRLICH07	1	1.14	1.66	1	1.43	1.31		0.797	1.267		
TOTAL	6	5.52	49.66	6	6.84	16.89		0.807	2.940		
MEAN	6	0.92	8.28	6	1.14	2.81		0.810	2.767		
STEP = GO											
NRLICH01	1	162.38	0.26	1	156.05	0.58		1.041	0.448		
NRLICH02	1	129.18	0.41	1	110.98	0.18		1.164	2.278		
NRLICH04	1	127.10	0.28	1	109.61	0.30		1.160	0.933		
NRLICH05	1	149.26	0.23	1	134.94	0.20		1.106	1.150		
NRLICH06	1	153.58	0.21	1	123.62	0.22		1.242	0.955		
NRLICH07	1	220.45	0.27	1	92.70	0.21		2.378	1.286		
TOTAL	6	941.95	1.66	6	727.90	1.69		1.294	0.982		
MEAN	6	156.99	0.28	6	121.32	0.28		1.348	1.175		

ARGONNE NATIONAL LABORATORY  
AMDAHL 470V/6 VS. IBM 370/195  
NRL BENCHMARK KERNELS

AMDAHL 470V/6

IBM 370/195

AMDAHL / IBM

## SUMMARY OF STEP TIMES (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
EDT	6	0.14	3.94	6	0.16	3.05	0.863	1.290
FTH	6	0.92	8.28	6	1.14	2.81	0.807	2.940
GO	6	156.99	0.28	6	121.32	0.28	1.294	0.982

## SUMMARY OF STEP MEANS (EACH JOB COUNTED ONLY ONCE)

STEPNAME	JOB(S)	CPU	WAIT	JOB(S)	CPU	WAIT	CPU	WAIT
EDT	6	0.14	3.94	6	0.16	3.05	0.863	1.407
FTH	6	0.92	8.28	6	1.14	2.81	0.810	2.767
GO	6	156.99	0.28	6	121.32	0.28	1.348	1.175



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